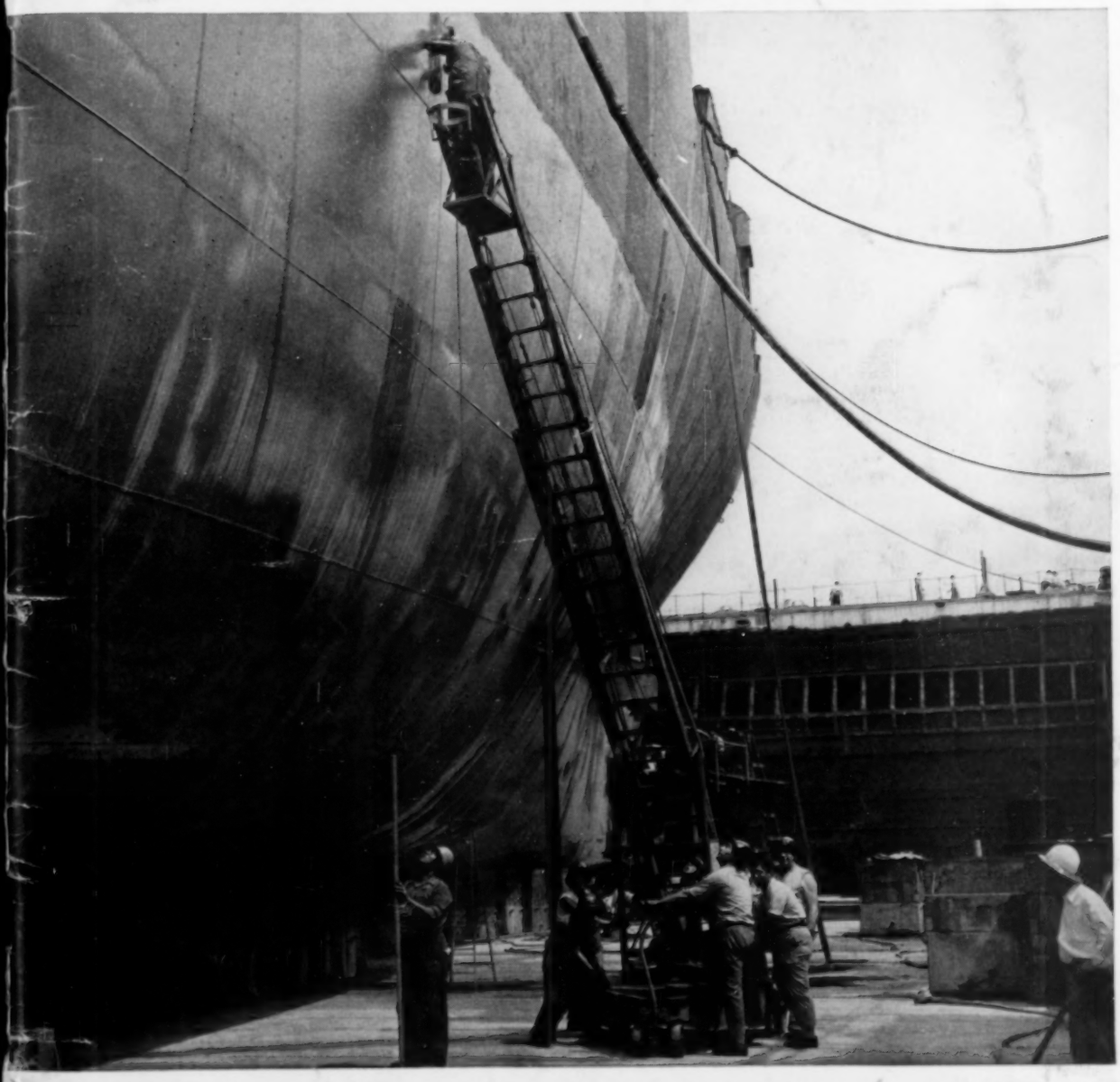
Compressed Air Magazine

OCTOBER 1946



SPRAYING PAINT ON SHIP'S HULL

A naval vessel in dry dock receiving poisonous coat to thwart marine growths

(See article page 264)

VOLUME 51 • NUMBER 10 NEW YORK • LONDON

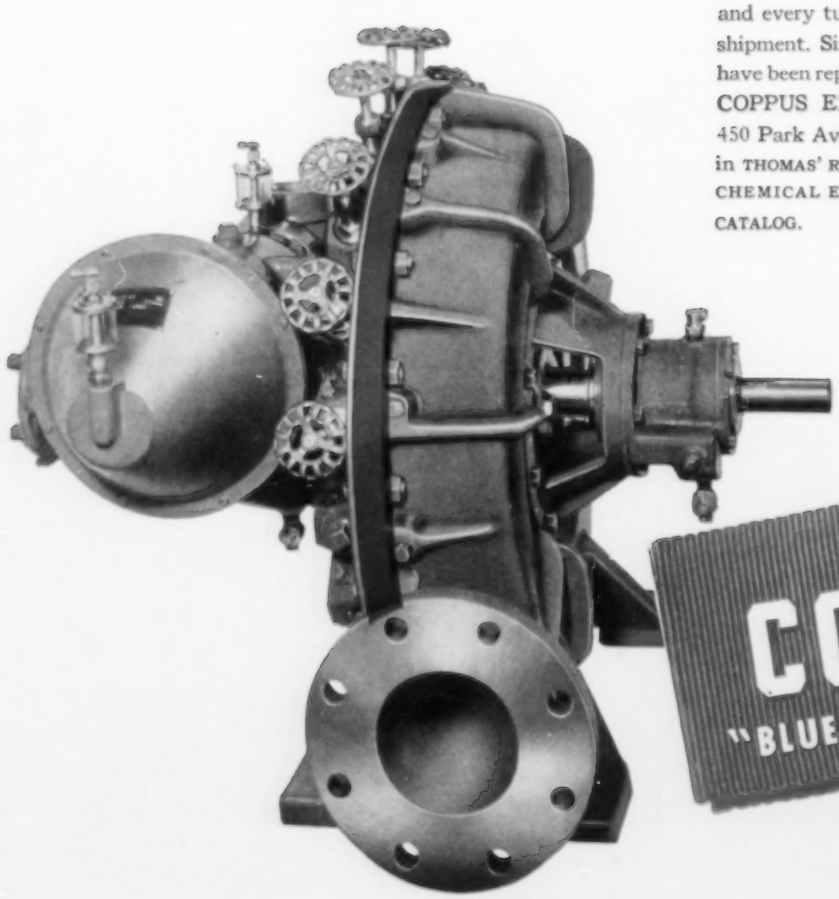
WHEN your equipment calls for small horsepower, you're saving money when a Coppus "Blue Ribbon" Steam Turbine is on the job.

Coppus makes turbines in six frame sizes from 150 HP down to fractional — so you can "fit" the power more closely to the need. No reason to pay extra for ordinary "elephant power" turbines, when you have a small horsepower requirement.

Many well-known manufacturers of original equipment have selected Coppus turbines. And they are to be found on U. S. destroyer escorts, driving vertical lubricating oil pumps . . . on U. S. Casablanca class aircraft carriers, driving main and auxiliary circulating pumps and fire pumps . . . on more than 90% of all Landing Ship Docks, driving condensate and clean ballast pumps.

A job for a Jeep, not a Truck

You, too, can rely on their dependable performance to meet your requirements for "jeep" power. Like all Coppus "Blue Ribbon" products (blowers, ventilators, gas burners, etc.), the Coppus turbine is a precision-made product — its accuracy controlled by Johansson size blocks — and every turbine is dynamometer-tested before shipment. Since 1937, more than 85% of orders have been repeat orders. Write for Bulletin 135-10. COPPUS ENGINEERING CORPORATION, 450 Park Avenue, Worcester, Mass. Sales Offices in THOMAS' REGISTER. Other products in SWEET'S, CHEMICAL ENGINEERING CATALOG, REFINERY CATALOG.



ANOTHER
COPPUS
"BLUE RIBBON" PRODUCT

WHY Clean Intake Filters More Than Once A Year?

YOU DON'T NEED TO WITH STAYNEW!!!

"When I first started as a maintenance engineer . . . more years ago than I like to admit . . . I found out for what long periods Staynew Intake Filters operate before cleaning is necessary.

"What's more, I found out that the high initial efficiency of Staynew Filters actually *increases* with use, because dust accumulates on the fins and forms a filter-aid of the very material being handled!"

Efficient Operation Up To 20 Months Reported By STAYNEW Users

TEXAS OIL OPERATOR:

"Conditions severe, but Staynew filters require cleaning only once every 15 months."

PENNSYLVANIA STEEL MILL:

"Staynew filters cleaned every 12 months."

MID-WEST CONCERN:

"Staynews throughout plant —average cleaning period, 18 months."

WEST COAST MANUFACTURER:

"Staynew intake filters operating at maximum efficiency after 20 months continuous service."

Model KE

Model C

Model D

Model DS

Model IDR

Models F and G

And When Staynews Do Require Cleaning... IT'S A CINCH!

These Staynew Intake Filters are dry type. There are no moving parts, no liquids, no reservoirs to be re-charged. They can be cleaned in just a few minutes by either vacuum or washing.

6 Models From 5 to 16,000 CFM

All Feature Original Radial Fin Design, Providing Maximum Filtering Area in Smallest Possible Space.

Model KE For small capacity use where weather housing is not required.

Model C Original *Protectomotor* design. For small capacity use where weather housing is required.

Model D The standard for heavy duty intake service on large engines and compressors.

Model DS Similar to Model D with the addition of a silencing chamber.

Model IDR Has the convenience of ground level installation plus the advantage of high level air intake.

Models F and G Low cost units for medium intake sizes.

COMPLETE DETAILS ON REQUEST

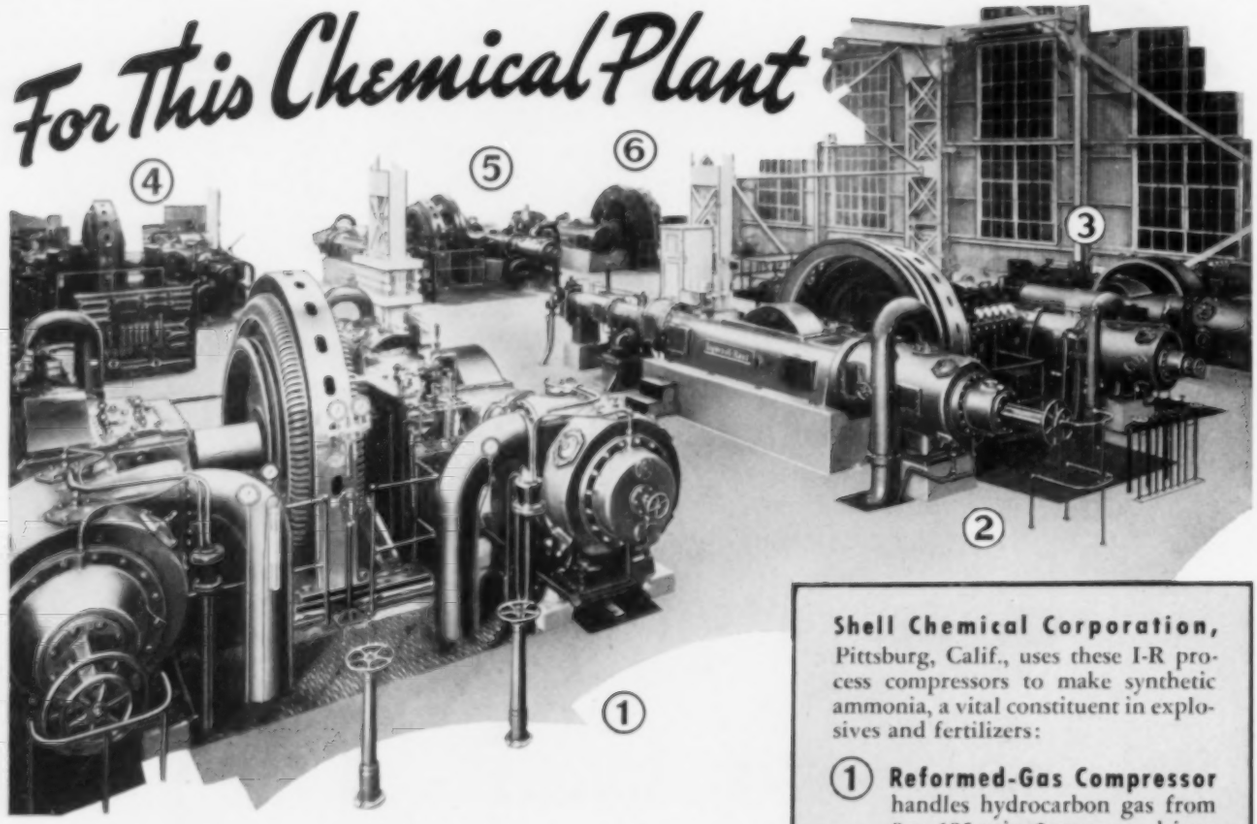
DOLLINGER PROTECTOMOTOR STAYNEW FILTERS

DOLLINGER CORPORATION

7 CENTRE PK., ROCHESTER 3, N. Y.

Representatives in Principal Cities

For This Chemical Plant



Shell Chemical Corporation, Pittsburg, Calif., uses these I-R process compressors to make synthetic ammonia, a vital constituent in explosives and fertilizers:

1. **Reformed-Gas Compressor** handles hydrocarbon gas from 0 to 185 psig, 2-stage . . . driven by a 1000-hp motor.
2. **Nitrogen Compressor** operates at 0 to 3000 psig, 5-stage . . . 600-hp motor.
3. **Ammonia Compressor . . .** 3 to 141 or 4.7 to 208 psia, 3-stage . . . 200-hp motor.
4. **Air Compressor . . .** 0 to 850 psig, 3-stage . . . 600-hp motor.
5. **Mixed-Gas Compressor** handles nitrogen and hydrogen . . . 145 to 3000 psig, 3-stage . . . 1000-hp motor.
6. **Circulator Compressor** handles hydrogen, nitrogen, ammonia . . . discharging up to 3000 psig, single-stage . . . 900-hp motor.

A maximum over-all plant economy was attained by making many of the frame, running-gear, cylinder, and motor parts interchangeable. Note the 4-corner construction (cylinder on each end of each frame) which provides maximum accessibility.

Each Compressor was built to do a definite job

These six I-R process compressors differ in the gases handled, the pressures generated, the horsepower required, and the operating characteristics. Each was engineered and built to perform its particular job with a high degree of dependability, with a saving in horsepower, and with an ease of operation and control.

Ingersoll-Rand has built the compressors for many synthetic ammonia plants all over the world, as well as for other processes and for handling all kinds of gases. Among these compressors are seven 2500-hp electric-driven seven-stage units compressing nitrogen and hydrogen gas to the super pressure of 15000 psi.

With such *experience* in building and applying compressors for process work, and with a standard line of air and gas compressors from ½ to 3000 horsepower designed for flexibility of application, there is a pretty good chance that Ingersoll-Rand has already built the kind of compressor needed for *your* process. If not, this *know-how* will serve as a background in meeting any new requirements you may have. Remember, Ingersoll-Rand can help solve your compressor problems.

SEVENTY-FIFTH IR ANNIVERSARY

COMPRESSORS • AIR TOOLS • ROCK DRILLS
TURBO BLOWERS • CONDENSERS
CENTRIFUGAL PUMPS • OIL AND GAS ENGINES

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y. 1-894

Make your Drills LAST LONGER

HARD ROCK drilling, excessive moisture —whatever the conditions—you'll get longer life, greater footage, more economical and trouble-free operation from your drills if you lubricate them with Texaco Rock Drill Lubricants (E.P.).

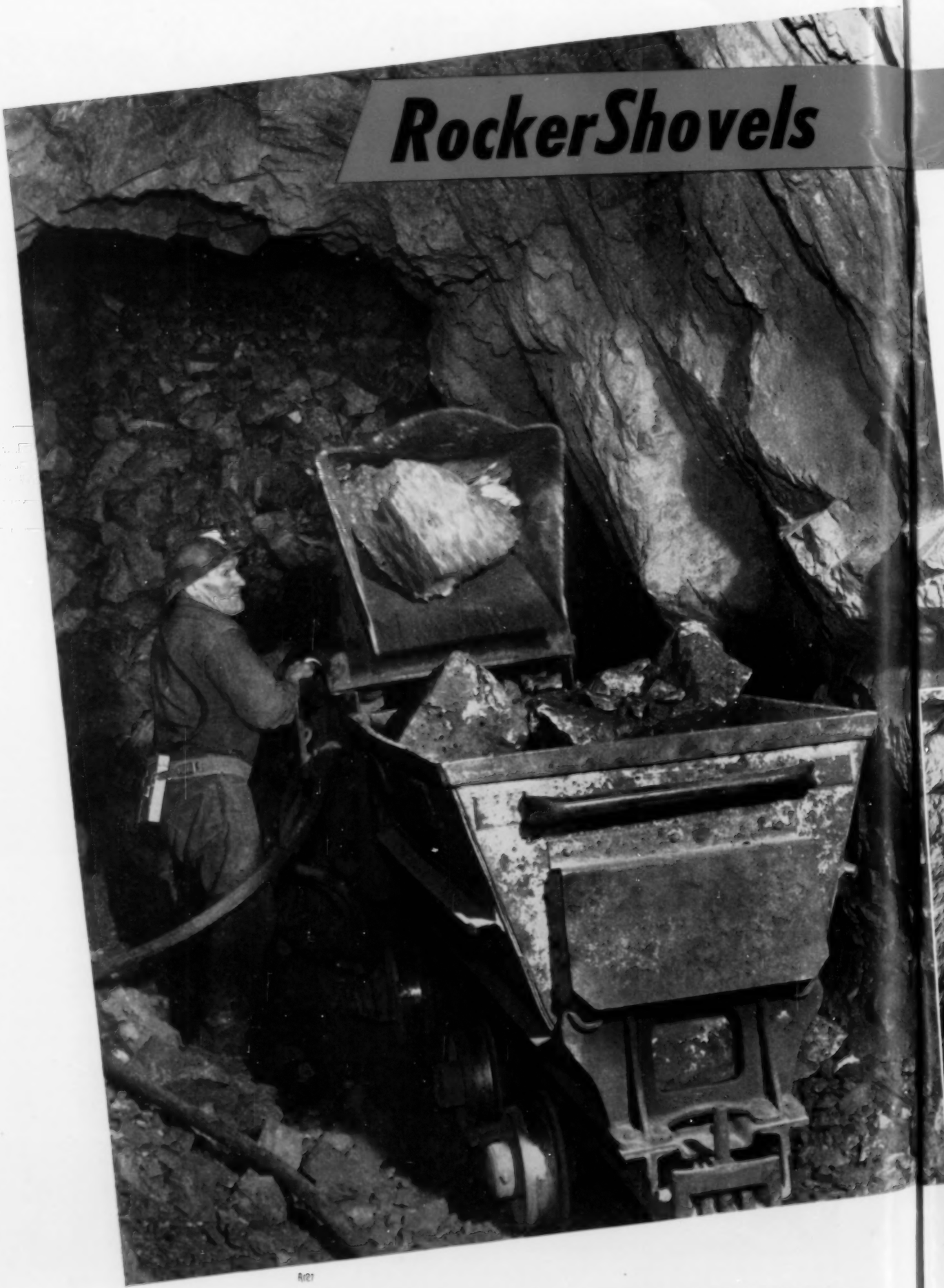
As the name implies, Texaco Rock Drill Lubricants (E.P.) are "extreme pressure" lubricants. Even under the severest loads, they keep all moving parts constantly covered with a tough oil film that reduces wear, repairs and costly delays. They lubricate effectively at all temperatures, resist wash-out, prevent rusting in service, standby or storage.

Texaco Rock Drill Lubricants (E.P.) have no objectionable odor. They meet the lubrication requirements of every type of drill design and operating condition, and conform to the lubrication specifications of all leading rock drill manufacturers.

For Texaco Products and Lubrication Engineering Service, call the nearest of the more than 2300 Texaco distributing plants in the 48 States, or write The Texas Company, 135 East 42nd St., New York 17, N.Y.

TEXACO Rock Drill Lubricants (E.P.)

TUNE IN THE TEXACO STAR THEATRE EVERY SUNDAY NIGHT — CBS


RockerShovels

at Darwin Mines

The Darwin Mines, producers of lead-silver ore, near Darwin, California, are using both Model 12B and Model 21 RockerShovels.

For development work and removing ore from draw-holes, the Eimco RockerShovels have done a remarkable job keeping production up and maintenance costs down.

Each model RockerShovel has a definite application in your mine. Each machine is assembled with the right size and shape of bucket, the right rocker-arms, the right deck, wheels, couplers and all other parts to assure you utmost efficiency in loading your cars.

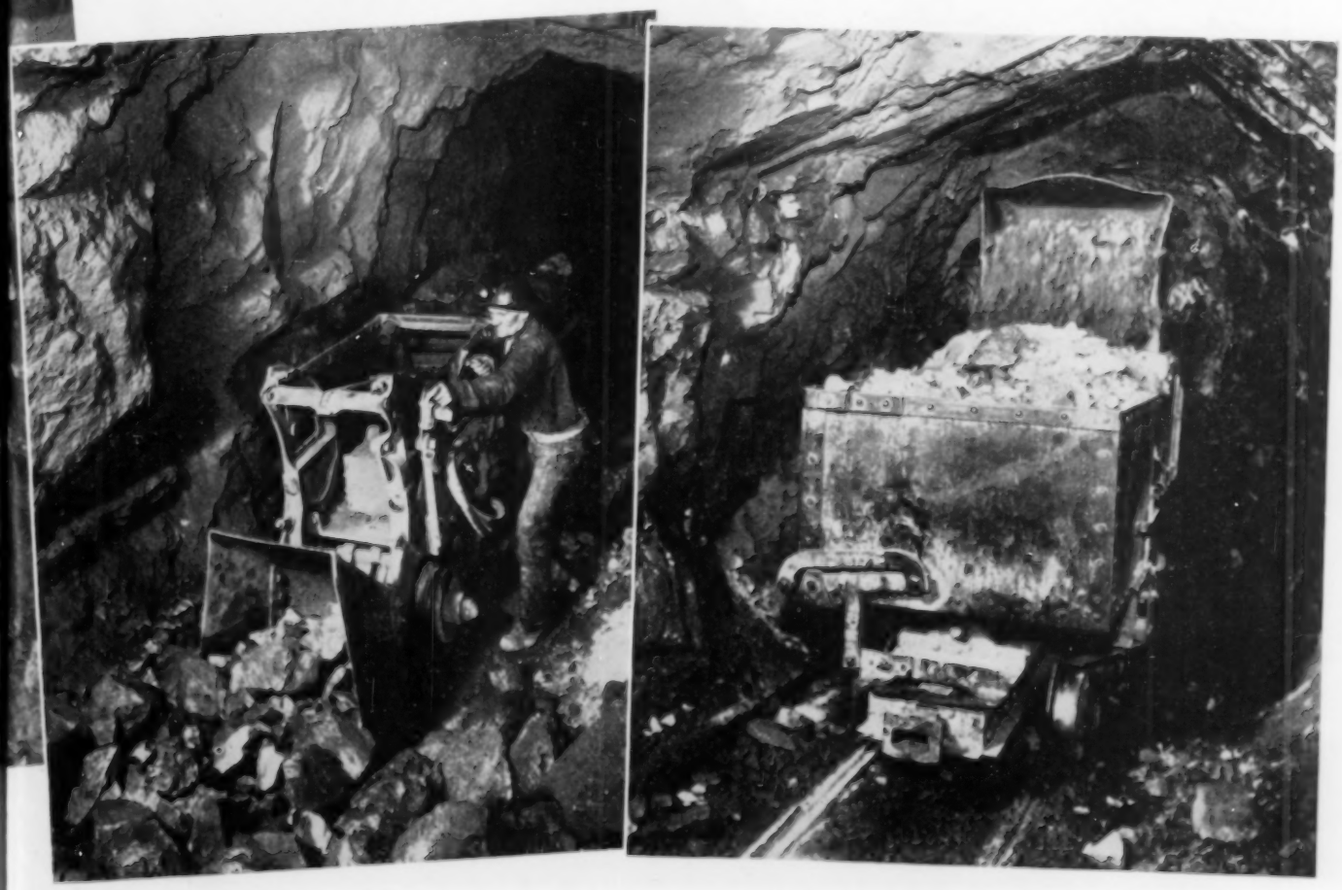
With more power, more speed and greater efficiency in loading than any comparable machine, you can depend on an Eimco. Let us help you solve your loading problems. No obligation of course!

EIMCO

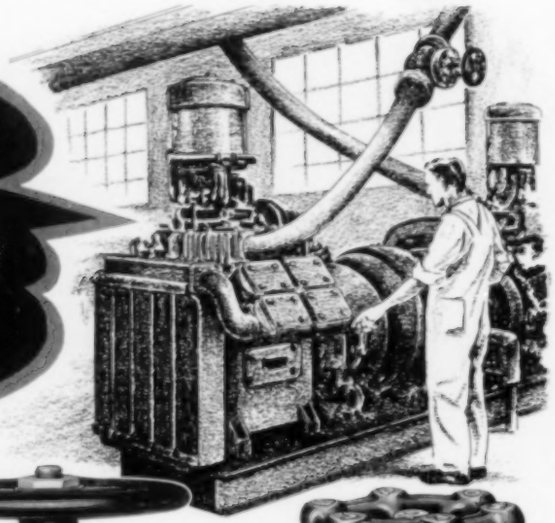
THE EIMCO CORPORATION

The World's Largest Manufacturer of Underground Rock Loading Machines

Executive Offices and Factories — Salt Lake City 8, Utah: Branches — 67 Wall St., New York 5 — 111 W. Washington St., Chicago 2 — Mills Bldg., El Paso — 1217 - 7th St., Sacramento 14



VALVES designed for Compressed Air Services



Years ago, when American Industry was still in its infancy, The Wm. Powell Company adopted a definite, farsighted policy . . . to concentrate on making valves only—valves of *every* design, for *every* service in *every* branch of industry.

That is why, today, Powell can supply valves to meet every requirement of the compressed air services, including all types necessary for controlling water for cooling compressors. And if any new demands arise, Powell Engineers will design valves to meet them.

Catalog covering the Powell Line of Valves for Compressed Air Services furnished on request.

Fig. 241—125-pound Iron Body Bronze Mounted Globe Valve. Has flanged ends, outside screw rising stem, bolted flanged yoke and regrindable, renewable bronze seat and disc. Also available in All Iron.

Fig. 375—200-pound Bronze Gate Valve with screwed ends, inside screw rising stem, union bonnet and renewable, wear-resisting "Powellium" nickel bronze disc.

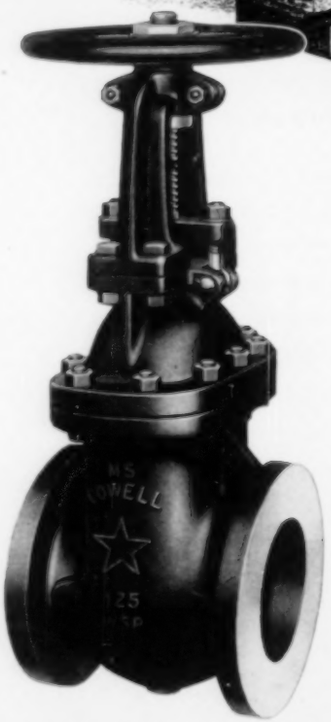


Fig. 1793—125-pound Iron Body Bronze Mounted Gate Valve with flanged ends, outside screw rising stem, bolted flanged yoke, bronze seat rings and taper wedge solid disc. Also available in All Iron.

Fig. 150—150-pound Bronze Globe Valve with screwed ends, union bonnet and renewable composition disc.

Fig. 95—Bronze Dash Pot Check Valve for 200 pounds air working pressure. Designed for air compressor service. Has screwed ends, screwed cap, and regrindable, renewable wear-resisting bronze disc. Because of the cushioning effect of the plunger in the dash pot, the seating of the disc is practically noiseless.

The Wm. Powell Co., Cincinnati 22, Ohio

DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

POWELL VALVES

AAF

AIR CLEANER PROTECTION

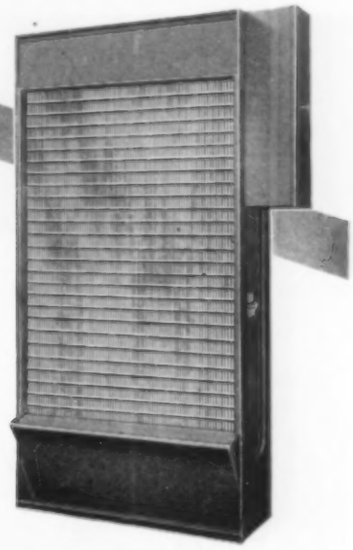
Means

LONGER LIFE

AND

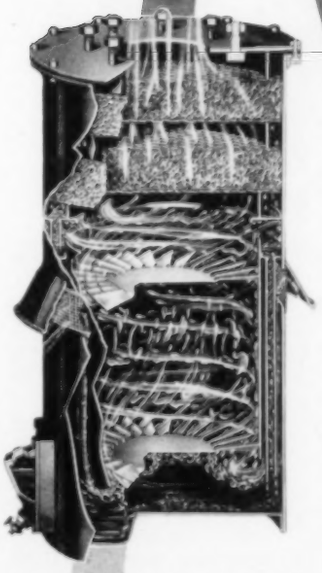
LESS REPAIR COST

PREVENTIVE MAINTENANCE in the form of correctly engineered air intake cleaners pays big dividends. Power plants are too precious and important to risk unnecessary shut downs and engine or compressor repairs. AAF's 25 years experience in the field of power equipment dust control is represented by a complete line of air cleaners and filters for every dust condition. Send for free engineering data and bulletins describing their installation and operation.

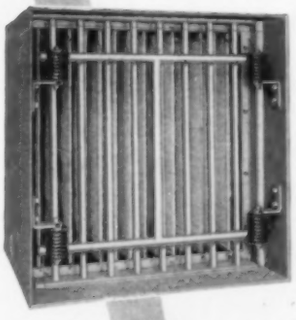


TYPE "PL-H" FILTER—A dry type filter employing wool felt as a filter medium. Recommended specifically for air compressors of the non-lubricated cylinder type and for engines and compressors where the intake air contains large quantities of lint, flour or other types of dust which do not suit viscous impingement type filters. Come as complete assemblies for installing on air intake pipes. Send for Bulletin 120 D.

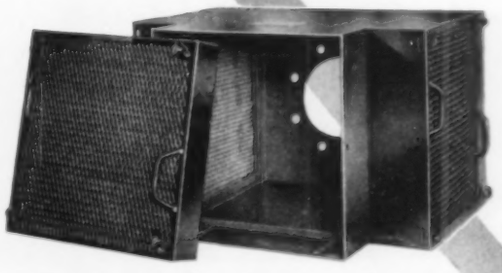
SELF-CLEANING AIR FILTER—For multiple engine or compressor hook ups, multi-cylinder, and four-cycle and two-cycle engines, the Automatic filter is especially suitable. Practical for air volumes of 5,000 cfm or more. For detailed information on its operation and self-cleaning principle write for Bulletin 241 A.



CYCOIL OIL BATH AIR-CLEANER—For engines and compressors subject to extremely heavy dust concentrations. Principle of operation provides four way cleaning — 1. impingement, 2. scrubbing, 3. cyclonic action, 4. filtering, thus assuring continued self-cleaning action and large dust-holding capacity. Acts as effective intake silencer as well. Write for Bulletin 130-D.



AAF ELECTRONIC PRECIPITATORS are available in three types—the dry media Electro-Airmat (illustrated); the self-cleaning Electro-Matic and the washable Electro-Cell with removable collector plates for easy cleaning. For use in larger installations and multiple engine or compressor hook ups. Send for Electronic Filter Bulletin.



TYPE "OC-H" FILTER—Composed of complete assemblies of individual viscous impingement type cells and housings which bolt directly to flange on air intake pipe. Installed outside or inside the buildings. Sturdily built for long years of service. Recommended particularly for use in industrial districts involving normal dust concentrations. Write for Bulletin 120 D.

AAF

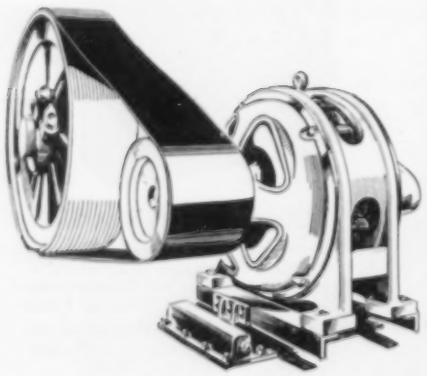
AMERICAN AIR FILTER COMPANY INC.

INCORPORATED

407 Central Avenue, Louisville 8, Ky.—In Canada, Darling Bros., Ltd., Montreal, P. Q.

A PERFECT PAIR

for making a profit



IN MODERN POWER TRANSMISSION

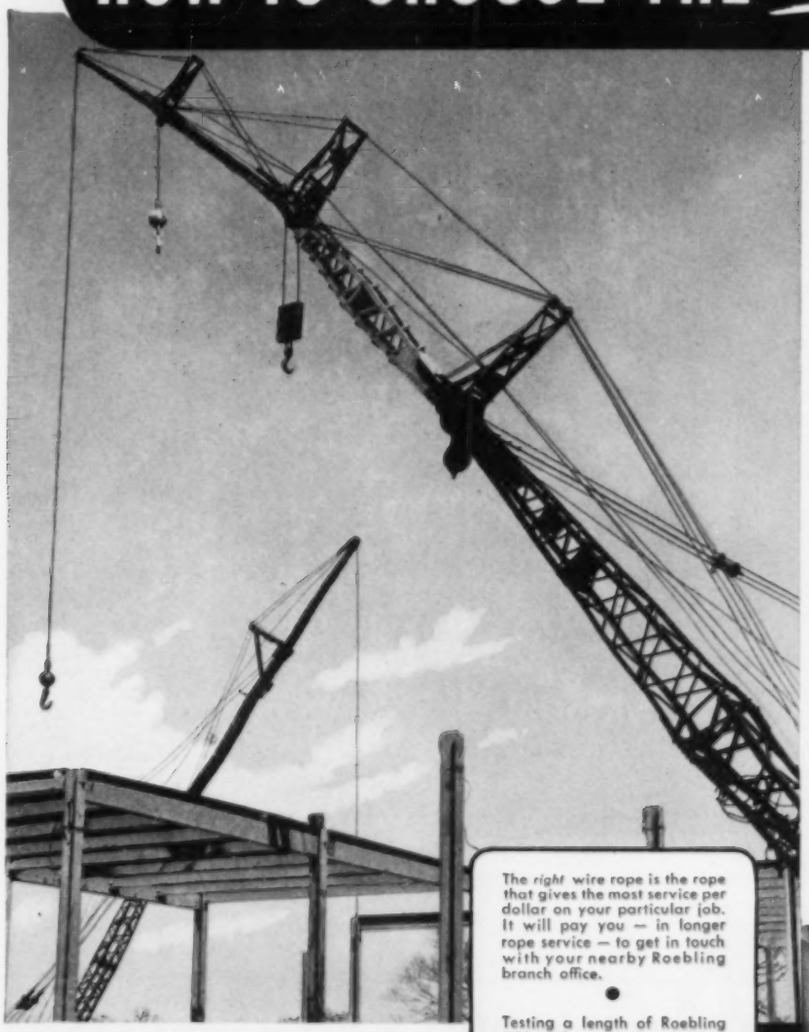
IT'S FLAT LEATHER BELTING

AND A PIVOTED MOTOR BASE

Not only in first cost, but in final total costs . . . and in the tremendously important factor of continuous, trouble-free operation . . . this modern compressor drive means greater manufacturing profits. No other method of transmitting power from motor to compressor is a bigger time- and money-saver than this combination of modern flat leather belting and a pivoted motor base.

AMERICAN LEATHER BELTING ASSOCIATION • 41 PARK ROW • NEW YORK 7, N. Y.

HOW TO CHOOSE THE *RIGHT* ROPE



. . . and get lowest handling cost!

YOU DON'T ALWAYS have the time to study the often obscure details affecting wire rope service on your installations. But your Roebling Field Engineer is constantly making such studies.

His daily contacts include tracking down the facts on practically every type of wire rope installation. He has specialized knowledge of wire rope usage . . . and of wire rope, too.

After careful study the Roebling Field Engineer can help you choose the *right* rope . . . the one that will give you top service per dollar. Of course, he will recommend Roebling "Blue Center" Steel Wire Rope. For here is a complete line—both preformed and non-preformed — where he can find the wire rope that combines the right balance of strength and flexibility, of fatigue and abrasion resistance.

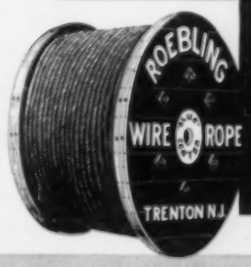
Call or write our nearest branch office. Get in touch with your Roebling Field Engineer.

JOHN A. ROEBLING'S SONS COMPANY
TRENTON 2, NEW JERSEY
Branches and Warehouses in Principal Cities

The *right* wire rope is the rope that gives the most service per dollar on your particular job. It will pay you — in longer rope service — to get in touch with your nearby Roebling branch office.

●

Testing a length of Roebling "Blue Center" Steel Wire Rope is important—*to you.* It gives engineering data to your Roebling Field Engineer . . . information that can save your wire rope dollars.



Manufacturers of Wire Rope and Strand • Fittings • Slings • Suspension Bridges and Cables • Aircord, Aircord Terminals and Air Controls • Aerial Wire Rope Systems Electrical Wire and Cable • Ski Lifts • Hard, Annealed or Tempered High and Low Carbon Fine and Specialty Wire, Flat Wire, Cold Rolled Strip and Cold Rolled Spring Steel • Screen, Hardware and Industrial Wire Cloth • Lawn Mowers

PREFORMED • NON-PREFORMED

ROEBLING

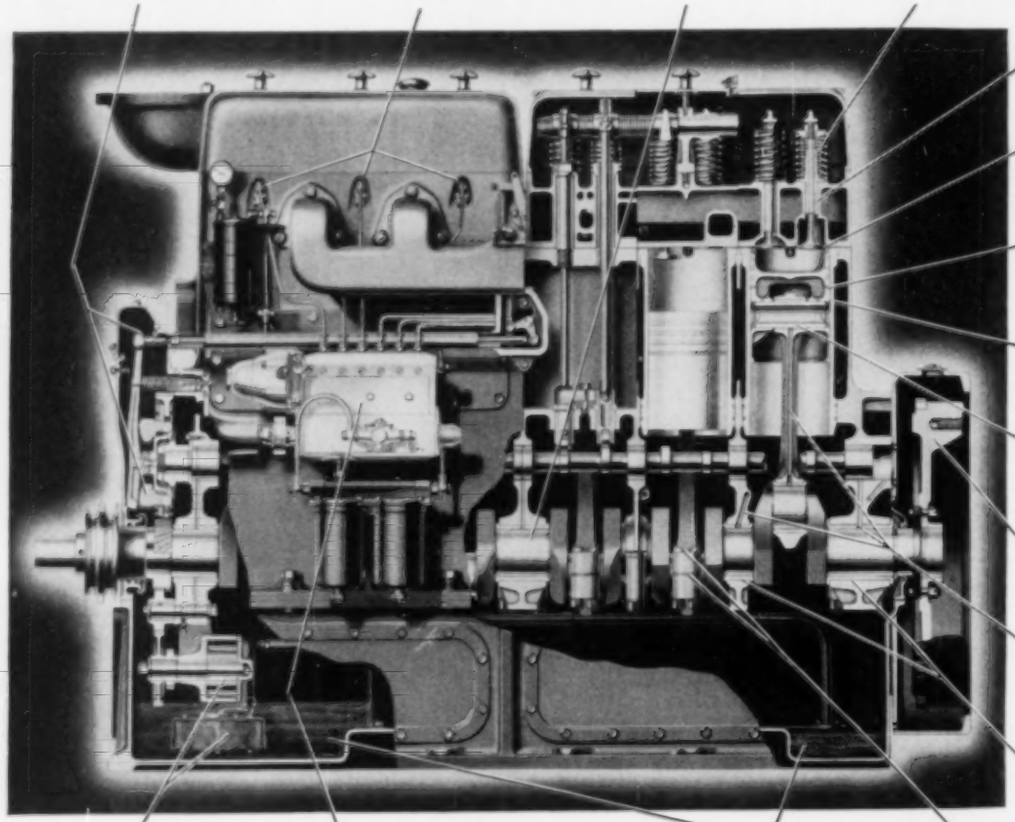
PACEMAKER IN WIRE PRODUCTS

Centrifugal governor completely enclosed, flood oiled.

Hesselman fuel injection nozzles.

7-bearing crankshaft with extra large center and rear bearings.

Double valve springs insure positive action and safety.



Removable and renewable valve guides.

Hardened exhaust valve seat inserts.

Four piston rings——all above pin.

Removable and renewable wet sleeve cylinders.

Full floating pressure-oiled piston pin.

Lightweight flywheel gives fast acceleration and lively performance.

Pressure oiling thru drilled passages to all bearings.

Renewable steel-backed babbitt bushings—rods and crankshafts.

Submerged intake, gear-driven pressure-scavenger pump and Oil Level Equalizer.

American Bosch fuel injection pump.

Double oil sump, with scavenger system for extreme angle operation.

Four bolts hold connecting rod caps—shims provide take-up.

16 Reasons ...and more for THE GREATEST OVERALL ECONOMY

MODEL 6-NKH WAUKESHA HESSELMAN OIL ENGINES

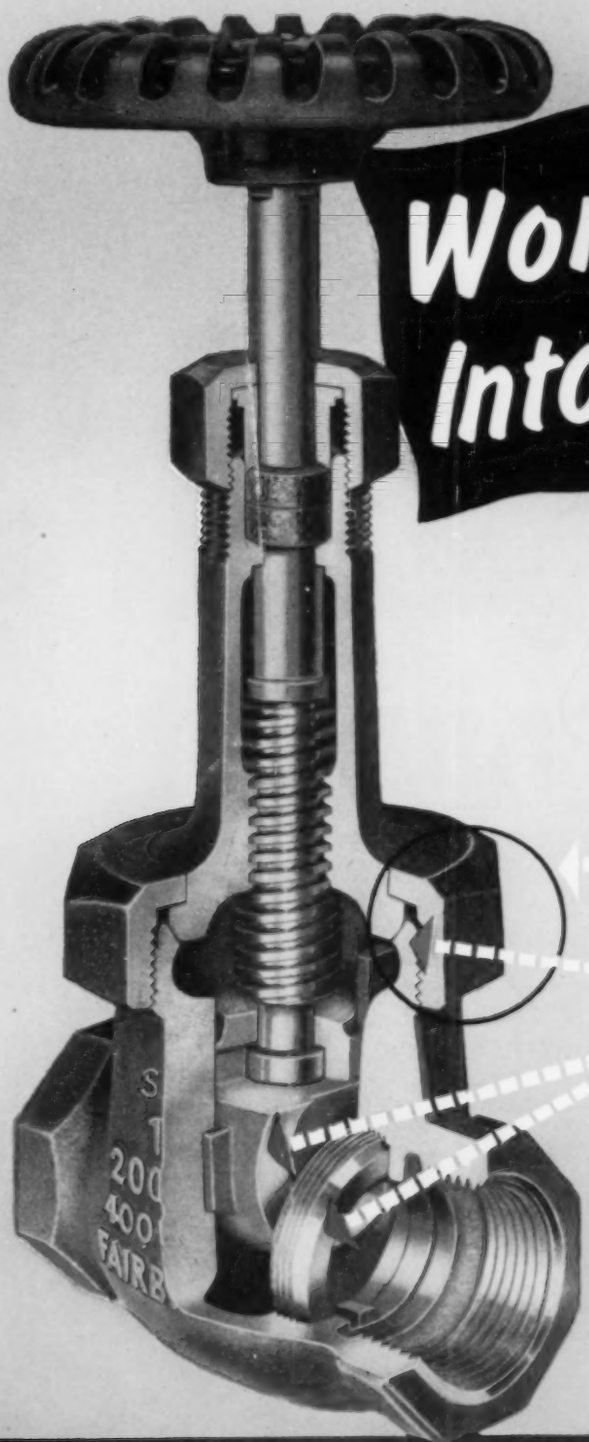
7" bore x 8½" stroke, 1962 cu. in. displ. burns diesel oil, or domestic furnace oils Nos. 1, 2 or 3—economical, easy-to-get fuels.

Note the 16 genuinely outstanding features that make the Waukesha-Hesselman *the world's most wanted diesel-oil engine.* It has many other features, too—designed for easier operation and greater convenience and accessibility in maintenance—electric starters, operating at the touch of a button, give prompt starting in all weathers . . . American Bosch heavy-duty magneto ignition . . . air blast or water cooling for exhaust manifolds . . . large inspection doors for easy inspection, adjustment, and renewal of internal parts. All these features *prove* Waukesha's *greatest overall economy!* It's an all-season, no shut down power unit engineered for country-wide use. Get Bulletin 1387.

WAUKESHA MOTOR COMPANY, WAUKESHA, WISCONSIN • NEW YORK • TULSA • LOS ANGELES

WAUKESHA *Oil* ENGINES

American industry flows through fairbanks valves



Worth Looking Into

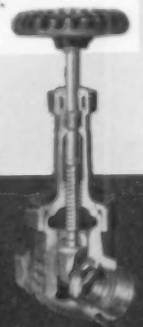
...One Fairbanks Valve
...Three Fairbanks Features

Union Bonnet Bronze Gate Valve for 200 lbs. Steam, 400 lbs. Water, Oil and Gas Pressure (Non-Shock)

While no picture can do full justice to ruggedness of design and construction, the big cutaway view gives you at a glance the most important features of a widely applicable valve suited for severe operating conditions in processing and other work.

- Union bonnet construction provides for easy dismantling and reassembly where frequent cleaning or inspection is necessary. Threads on outside of body are not subject to attack by fluids in line.
- Heavy octagonal bonnet nut holds radial body bonnet joint in pressure-tight alignment.
- Nickel alloy wedges and renewable seat rings provide extra long service through hardness and resistance to corrosion under pressure. Valve may also be had with integral bronze seats.

This valve is furnished with rising or non-rising stem. Low in maintenance cost, this 200 lb. bronze gate valve is typical of the Fairbanks line of bronze, iron body, and all-iron valves. Write today for further information.



THE **fairbanks** COMPANY

393 LAFAYETTE STREET, NEW YORK 3, N. Y.

520 Atlantic Ave., Boston 10, Mass. 748 M & M Bldg., Houston 2, Texas 15 Ferry St., Pittsburgh 22, Pa.

IT'S WORTH LOOKING INTO BY *EVERY INDUSTRIAL DISTRIBUTOR* interested in a feature-crammed profit-building valve item "made to order for orders" . . . strongly backed by the long-established name of a well-known manufacturer.

YOUR FOREMEN KNOW SOMETHING SIGNIFICANT

that your Purchasing Agent shouldn't forget-

i.e.

Manufacturers of the highest grade machine tools, compressors and work engines use Madison-Kipp Lubricators as standard equipment.

i.e.

You will have trouble-free operation for 20 years and longer with Madison-Kipp Fresh Oil Lubrication.

i.e.

Madison-Kipp is the most dependable method of lubrication ever developed.

i.e.

To specify Madison-Kipp on all new machines you buy on which Fresh Oil can be applied, drop by drop, under pressure.

MADISON-KIPP *Fresh Oil*

FED UNDER PRESSURE BY THE MEASURED DROP

MADISON-KIPP CORPORATION
202 WAUBESA STREET, MADISON 4, WISCONSIN, U. S. A.

Skilled in die casting mechanics, experienced in lubrication engineering, originators of really high speed air tools.

ANCIENS ATELIERS GASQUY, 31 Rue du Marias, Brussells, Belgium, sole agents for Belgium, Holland, France and Switzerland.

WM. COULTHARD & CO. Ltd., Carlisle, England, sole agents for England, most European countries, India, Australia, and New Zealand.

Running to Ruin

...SO THAT YOU WILL GET LONGER LIFE FROM EVERY TEXROPE V-BELT

THIS MACHINE tests TEXROPE Super-7 V-Belts — runs them at varying speed and load until they give out. A trained operator records results: How long did they last? What broke down first: Cords? Cover? Rubber compound? Does destructive heat develop?

Out of tests like this have come stronger cords—tougher, more wear-resistant covers — resilient, cooler-running rubber — vital improvements in design and construction. TEXROPE Super-7 V-Belts are today the BEST in 20 years of V-Belt experience.

A-C FOR COMPLETE V-BELT SERVICE

Call your nearest Allis-Chalmers office or dealer for ALL your V-Belt drive needs — TEXROPE Super-7 V-belts all types, all sizes; TEXSTEEL, TEXDRIVE and "Magic-Grip" Sheaves; VARI-PITCH Sheaves and SPEED CHANGERS. They're all engineered and backed by the originators of the Multiple V-Belt Drive for industry. ALLIS-CHALMERS, MILWAUKEE 1, WIS.

A 2099

PICK YOUR SUPER-7 V-BELT

Heat-Resisting Super-7
Stands temperatures up to 180°. The TEXROPE V-Belt for most drives.

Oil-Resisting Super-7
Neoprene cover protects core against moderately oily or greasy conditions.

Oil-Proof Super-7
Made of Neoprene throughout. Use it when the belt must swim in oil.

Static-Resisting Super-7
Recommended where explosion hazard exists. Static-conducting element throughout cover won't wear off.

TEXROPE Super-7 V-Belts result from the co-operative research of two great companies—Allis-Chalmers and B. F. Goodrich—and are sold exclusively by A-C.

ALLIS-CHALMERS

One of the Big 3 in Electric Power Equipment — Biggest of All in Range of Industrial Products

TEXROPE V-BELT DRIVES

SERVING YOU THROUGH SCIENCE

Specially compounded tube adds extra hours of service.
Braided-steel-wire safety plies embedded in rubber prevent bursts.
Spiral cord asbestos ply bonds cover to the carcass.
Extra tough cover withstands heat and external abrasion.
A "U. S." ENGINEERED RUBBER PRODUCT

WITHIN AN INCH OF HIS LIFE!

Live steam surges through the flexible hose this worker is using—at pressures comparable to those which can drive a locomotive.

Yet this worker is fully safeguarded. For U. S. Rubber engineers so designed this U. S. Matchless Steam Hose that it will not burst even under 200 pounds pressure.

If, after extra long service, steam finally penetrates the inner lining, there is no explosion. A flexible fortification of braided steel wire plies checks the escaping steam, allows it merely to seep through the tiny perforations. This is an indication that replacement is needed.

Such vital developments in design are typical of what U. S. Rubber engineers have contributed to all types of hose—compressed air, welding, water, rotary, gasoline and other Engineered Rubber Products for industry.

UNITED STATES RUBBER COMPANY

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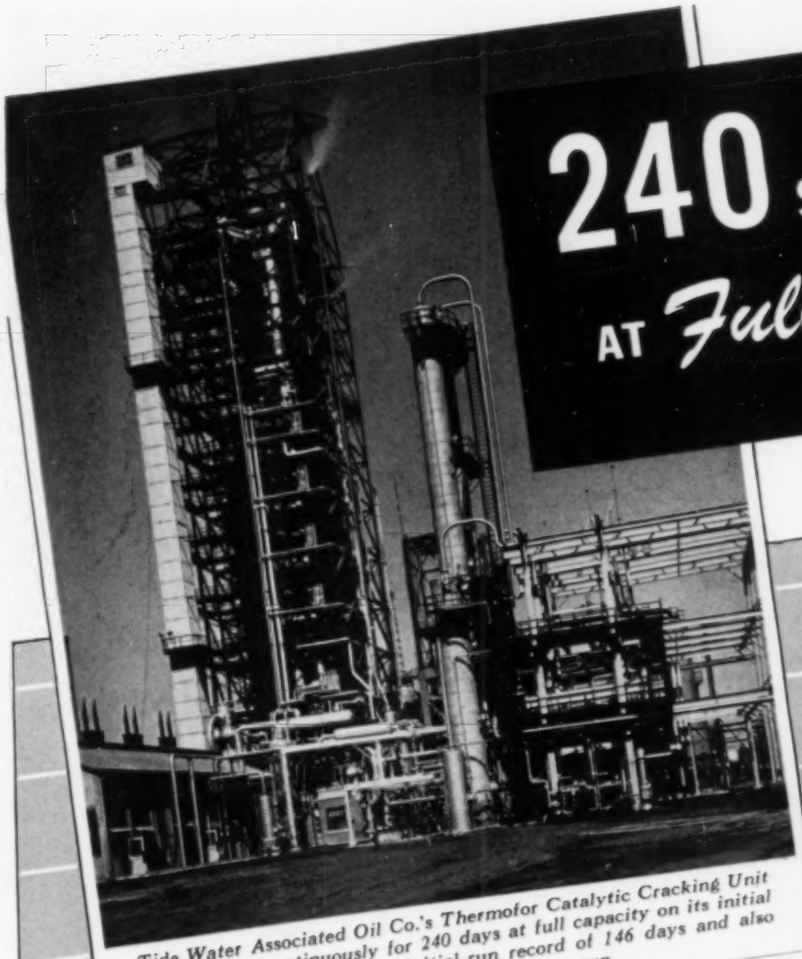
240 STRAIGHT DAYS AT *Full Capacity*



Tide Water Associated Oil Co.'s Thermofor Catalytic Cracking Unit 8, which ran continuously for 240 days at full capacity on its initial run, breaking the previous initial-run record of 146 days and also the record of 217 days for any run

Tide Water Cracking Unit Sets 2 Records for Continuous Run

Herbert Chase, vice-president of Tide Water Associated Oil Co., announced yesterday that two world records for continuous operation of a Thermofor catalytic cracking unit have been established by the company's Unit 8 at its Bayonne, N. J., refinery. The unit operated at full capacity for 240 days without a shutdown, thus surpassing not only the previous record of 146 days for an initial run, but also the record for any run of 217 days by a similar unit.

The unit was placed "on stream" May 12, 1945, and operations were continuous until Jan. 7, 1946, when the unit was shut down according to plan for minor repairs and inspection. The circulation of catalyst never faltered and the kiln operated all the time, Mr. Chase said.

The run was considered the more remarkable because the Bayonne unit is dependent upon integral gas equipment to handle the gas produced, and any fault in this equipment would have shut down the unit. Careful inspection after the shutdown revealed, Mr. Chase said, that the unit was in excellent condition.

Catalyst losses were reported as lower than loss[es] other units, an[d] estimates.

The unit ch[arged] 10,500 barrels a [day] and circulated 100 [tons] bead catalyst.

Because it was [the] model unit, the cr[ack] been inspected [by] England, Russia, France and Holland, and also by representatives of numerous companies in the United States.

I-R REFINERY PUMPS WITH CAMERON SHAFT SEALS CONTRIBUTE TO EXCELLENT RECORD OF CATALYTIC CRACKING UNIT OF TIDE-WATER ASSOCIATED OIL CO.

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ON THE COVER

AS AN article in this issue points out, great progress has been made in recent years in developing antifouling paints for ship bottoms. Coincidentally, the use of labor-saving tools, including air-operated spray guns, and the creation of other mechanical aids have greatly reduced the painting time. As a result, four sprayers using two outfits can now cover as much surface in a day as twenty hand painters could formerly. Our cover picture shows one of the mobile, adjustable ladders that contribute to time saving. It is being moved while the painter remains at his working station. In addition to expediting the work, these ladders improve the safety record.

•

IN THIS ISSUE

ALTHOUGH leather has been made for untold centuries, it still remains an essential commodity that modern ingenuity has failed to displace or replace. And despite the fact that men have been making leather for so long, tanning still remains an art in that the results achieved depend more upon human skill and judgment than on exact laboratory formulas. Our leading article, which is the first of two, should make us all more leather conscious.

•

MARINE organisms that attach themselves to the hulls of vessels slow their progress and also necessitate the use of additional fuel to drive them through the water. This age-old problem of mariners is especially pronounced in warm waters. To merchant ships it is only bothersome and expensive, but to naval vessels engaged in combat it can be fatal. During the recent war, great strides were made in combating this fouling through the use of poisonous plastic paints. Details are given in *Baffling the Barnacle*, which starts on page 264.

•

TOM McCONLOGUE, the author of *Air Under the Sea* (page 270) is well qualified to write about the wartime salvage work that he describes. Interrupting his studies at Moravian College, Bethlehem, Pa., he entered the Navy in May, 1943, and received diving instruction at three training schools on the continent and one at Pearl Harbor, Hawaii. From then on he was engaged in subaqueous operations in various parts of the Pacific until his discharge in February, 1946, with the rating of machinist's mate, first class. He is now back in college, content to let others emulate the creatures of the briny.

Compressed Air Magazine

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VOLUME 51 **October, 1946** NUMBER 10

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Published by Compressed Air Magazine Co., G. W. MORRISON, *President*; C. H. VIVIAN, *Vice-President*; J. W. YOUNG, *Secretary-Treasurer*.
Business, editorial, and publication offices, Phillipsburg, N. J.
Advertising Office, 11 Broadway, New York 4, N. Y., L. H. GEYER, *Representative*.
Annual subscription: U.S., $3.00; foreign, $3.50. Single copies, 35 cents.
COMPRESSED AIR MAGAZINE is on file in many libraries and is indexed in Industrial Arts Index.

The Story of Leather

J. Edgar Rhoads

MANY of us who are closely associated with modern industry have been fascinated by the speculation as to when and how prehistoric man first began to have some understanding of the potentialities of fire and of the labor-saving wheel. Possibly thousands of generations passed between the era of the Chinaman whose house burned down and roasted a young pig, as narrated by Charles Lamb, and the day when someone discovered that fire could be used to boil water for cooking. Similarly, there must have been a very long lapse between the time a primitive boy first rolled a stone downhill, and thought how delightful it would be to travel at that speed, and the period when his descendents put an axle between two crude wheels to make a war chariot.

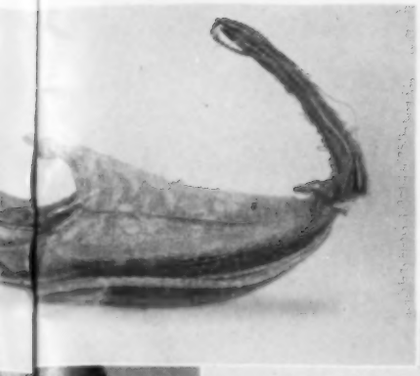
Leather, by which is meant animal skin that has been treated or preserved to keep it soft enough for clothing, shelter, harness, or war gear, may have had its inception somewhere near one of those far-distant dates and has found increasing application with the advance of civilization. It would take too long to list, let alone detail, all the uses to which man has put that material through the ages.

Library of Congress Photo

U. S. Forest Service Photo

Probably it first served him as a garment or as bedding. Be that as it may, we will attempt to describe briefly but a few of the early applications, to touch lightly upon the romance of the industry itself, and to tell how leather of many kinds makes modern existence more pleasant and helps us to perform some of our important tasks.

Many primitive peoples have had superstitions or religious convictions about certain animals, and some still hold them sacred. Perhaps this was the origin of the belief that their hides or skins, or leather made from them, have healing powers. With some tribes it was the practice to wear a piece of skin or leather to ward off evil spirits and to insure health. In-



United Shoe Machinery Corporation Photo

fants, especially those of premature birth, were occasionally swathed in skins to protect them. Physicians of ancient days covered or wrapped their patients in skins believing that, in addition to warmth, they had curative powers. Tales of witchcraft and folklore of Teutonic and other European peoples and of those of the Far East are full of such references, and many of those legends and superstitions have been handed down to the present century by the peasantry of the Old World, that of Austria for one place.

Human life depends upon the maintenance of an even body temperature. The blood must always be close to 98.6°F., otherwise illness, or even death, may result. Because of this, primitive man was confined pretty much to the temperate zones. However, when he found that garments made of animal skins would keep him warm and that sandals of hide or leather would protect his feet, he pushed vigorously into areas that would have been unendurable without them. Leather and furs played an important part in this period of our development. Tribes that were shod and well clothed had numerous advantages over their less-energetic rivals who lacked these things because they could move farther and faster and provide themselves better with sustenance. In addition, they made leather and skins into tents, beds, and rugs, as well as armor. And later, when horses were first used in warfare and for haulage, leather harness made its appearance.

The ancients learned to keep water and fermented fruit juices in bags of animal skins or leather, thus further increasing their radius of operations. They found that preserved or tanned leather was sufficiently porous to allow a small amount of fluid or air to pass through and that the resultant evaporation kept the liquid slightly cool. The Bible makes numerous references to such bags. It was also discovered that raw strips of hide, when

ABOUT THE AUTHOR

Mr. Rhoads is senior partner of J. E. Rhoads & Sons, Philadelphia, Pa., leather manufacturers. The firm was established in 1702, and is the third oldest industrial concern in the United States. A son of the author, who is now in the business, represents the eighth generation of the family to be associated with it. Some of Mr. Rhoads's ancestors are believed to have made leather in England prior to 1700.

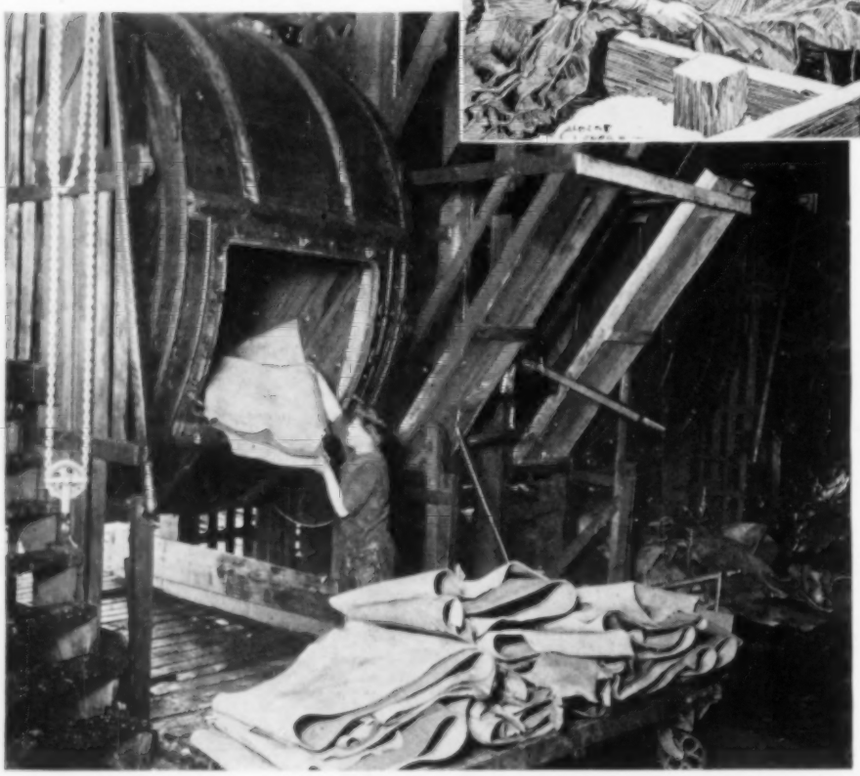
PERTAINING TO LEATHER

Yearling steers grazing on a Montana range (preceding page) represent leather on the hoof. The electrical lineman (center) uses leather liberally in his clothing and equipment. At the University of Cincinnati, the Tanners' Council of America maintains a research laboratory (above) for the continual improvement of leather. Red leather sandals worn by an ancient Egyptian (above laboratory view) are now displayed at New York's Metropolitan Museum of Art. The shoe pictured at the top-center is a crakow (from Cracow, Poland) that was worn about 1470. The style originated in India and Persia. The long toes, called poulaines, sometimes reached to the knees and were fastened there by silver chains. Laws of the church and state finally prohibited the wearing of this grotesque footgear, and it disappeared around the end of the fifteenth century.

TANNING LEATHER

At the right, Colonial settlers are depicted putting hides and bark into vats for tanning. The other view shows leather being removed from a drum where it has been treated to restore the oil that was removed during the tanning process.

Tanners' Council of America Photo



used to fasten arrow or spearheads to a wooden shaft, would shrink and dry and hold them securely. Narrow strips of this kind made excellent bow strings, and a thin skin dried over a hollow log provided a wonderful drum for ceremonial purposes or for sending out alarms. Many of our museums have on display articles of clothing and crude footgear, harness, and other leather products dating back 3000 years and more.

At the time of Homer, and when the Jews were in captivity in Babylon, the Greeks and the Babylonians already had attained much skill in tanning leather and in converting it into many useful things. The Greeks may have been the originators of "chamois," for they are known to have used oils which they forced into the hide by hand or by pounding while it was stretched on a frame or staked on the ground, usually after the hair had been removed. Greeks and other Mediterranean peoples learned that unhairing could be easily accomplished by soaking the hides in limewater. Oak bark and other vegetable materials were used by the Hebrews and other Mediterranean tribes for tanning

When leather sandals, shoes, clothing, saddles, harness, etc., were no longer novelties, it was only natural that the ruling classes should want something better than the common run of articles, and so the art of carving and decorating leather was developed to a high degree. Colored embroidery, gold and silver, and even jewels were used for ornamental purposes, and were frequently so applied to shoes or garments as to indicate the rank of the wearer. Down through the centuries, the warriors of Greece, Rome, and Egypt, and later the Anglo-Saxons, Tartars, and Chinese under Kublia Khan wore clothing and armor made largely of leather or rawhide. Subsequently, the Arabs introduced into Europe their beautifully decorated leather saddles and harness. The craft was preserved in Spain and carried to the New World, where it is still appreciated by our western cowboys.

In England and in France, leather guilds became very strong, and it was obligatory that the workers be rigorously trained and that members attain the highest order of craftsmanship. In France, the Fraternity of Leather Workers dates back to 1397. The right to become a tanner was bought from the king for sixteen sous, and each member swore to observe the customs and moral precepts of the trade. During this period the guilds in many lines of industry created powerful monopolies through royal charters.

Before the invention of type, books often had parchment pages lettered by hand and beautifully "illuminated" in bright colors, gold, and silver. Most of this magnificent workmanship was done by devoted monks with their brushes and pots of paint, and monasteries therefore possessed the finest libraries. Rolls of skins that served the ancient Egyptians as books are still in existence and are about 3500 years old.

Many of the early Americans brought some knowledge of leather making to this country from the Old World. Tanneries were active near all the settlements in Colonial days, many of them producing very creditable leather not only from the skins of native animals such as deer, moose, and buffalo but also from domestic calf, cattle, and sheep. Later they imported goatskin. When the settlers came to these shores, native Indians were already making excellent "buckskin" much of it from deerskin treated in a way to give it the quality to withstand wetting and drying and still remain soft and pliable. Crow Indians were supposed to have attained the greatest skill in this work, and the writer has some leather of this description that is more than 80 years old and still in an excellent state of preservation.

The Indians, however, knew nothing about bark tanning and, consequently, could not produce leather suitable for the soles of shoes. Their buckskin, used mostly for making clothing and tepees, was as perfect as anything they could get for their life in the woods. But for shoes, boots, saddles, harness, buckets, and hose; for the large bellows by which fires were blown in forges for smelting iron ore and in homes; for straps to support the bodies

of Colonial coaches drawn by four horses or more; and for many other applications, leather made by tannage principally with oak bark was far superior. Some of that early material is still in existence and in fairly good condition, although lacking its original strength. The masters and workers who labored in the tanneries and leathercraft shops were largely men who had served long apprenticeships and who followed the rule-of-thumb methods that had been found to give reasonably good results.

At the time of the Revolution there were probably several hundred small tanneries and leather shops in the country. They were scattered mostly throughout an area extending from the Massachusetts Bay Colony to South Carolina and sold their goods made of local hides and raw materials to nearby settlers. Generally, the skins were soaked in water and then in limewater until the hair was loosened. Next they were put into crude vats in the ground and sprinkled, layer after layer, with pounded oak bark until the vats were full. That done, enough water was added to cover the hides, which were then left to soak for several months, fresh bark being applied occasionally as the tannin was absorbed.

In eastern Pennsylvania, where my ancestors carried on such work for several generations, oak bark was used almost exclusively until it became scarce there. Then they began to draw upon a greater area for that material and to add other bark such as hemlock to stretch the supply and to reduce the cost. Our family account books throw light on the nature of this business, on the prices paid for different raw materials, and on the supplies bought for the use of the family and of the workers. For nearly a century the entries were in pounds, shillings, and pence.

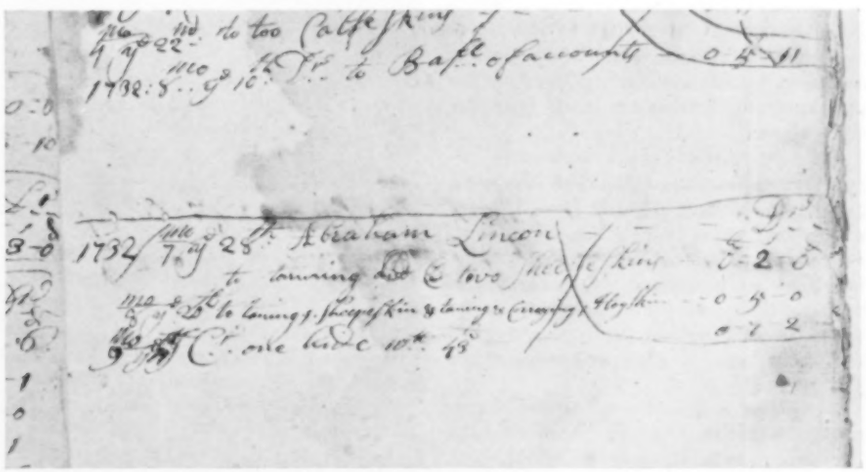
Probably the most striking thing about the purchases is that they were so few in number, compared to the present-day requirements of a family. Our forebears were independent, and grew and made most of the things they needed. They did, however, buy syrup, rum, "tobak," a few simple implements, some "lining cloth"—probably linen—and wool that they spun and wove themselves. One of our illustrations is a reproduction of an account that is well worth commenting upon because it lists transactions between Joseph Rhoads and Abraham Lincoln (spelled Lincon), apparently a great uncle of the president, who had come down from near Plymouth, Mass., to settle on the Schuylkill River some miles above Philadelphia. There he established a forge, which was the trade his father had taught him in Massachusetts. The Lincolns later moved farther south to the Cumberland Valley in Virginia and to Kentucky.

As was to be expected, the small local tanneries were supplanted in time by larger concerns with more capital and more machinery that used scientific methods and produced a greater variety of improved types of leather. Sir Humphry Davies, the English scientist, discovered that valuable tanning materials could be extracted from other than oak bark and that tannin was present in the bark and sometimes the wood of other trees and plants in different parts of the world. The American chemist Augustus S. Schultz found that some of the salts of chromium were suitable for making leather. His early work was followed up by various men in the tanning industry. In Philadelphia, Robert Foerderer, after long experiments, developed a successful method of treating chrome-tanned leather to give it softness and pliability. This process opened up a great field in the manufacture of upper leather for shoes and was especially applicable to light skins such as sheep and goat. For heavy leather—sole leather, belting, and mechanical leather—vegetable tannage was usually preferred because it gave a superior product.

About that time many improvements were made in leather-working machinery, with the result that unhairing and shaving of the flesh and the application of grease or oil to the skins or hides could be done much better and more uniformly than by the old hand methods. A machine for leveling or splitting leather to an even thickness was perfected. And perhaps as important as any of these was the development of a successful process for extracting the tanning material out of the raw bark or wood and applying concentrates in the form of extracts to the hides. This was a big step forward in that it made for speed and uniformity of tanning. The preparation of extracts from chestnut wood and other materials near the sources of supply became a business in itself and brought about not only a saving in time but in freight charges.

Great improvements were made also in the manufacture of shoes. No longer was it necessary for the village shoemaker to do the work by hand. Machines were built to cut, sew, and "last" the leather quickly and accurately, and lasts made it possible to turn out far better fitting shoes for individual feet. Production costs were reduced to a point where nearly everyone was able to have a decent pair. Today the domestic shoe industry uses more than three-quarters of the leather made in the country. This year it is expected that the total output will reach, if not exceed, 500,000,000 pairs of shoes.

As tanneries grew and had better equipment and control of their processes, including drying (which is vital from the standpoint of quality of finished leather), rail transportation was established and permitted shipping the more standardized



OLD RECORDS

The earliest existing account book of J. E. Rhoads & Sons is reproduced at the left. It was used from 1726 to 1738. The other picture shows an entry made in 1732 of the sale of a forge bellows to Abraham Linco(l)n, great uncle of the president.

Tanners' Council of America Photo

CATTLE AT CHICAGO STOCKYARDS

Most of the hides used in the leather industry are by-products of the packing industry.

product great distances. While the largest centers of the industry still remain in New England, Pennsylvania, and other eastern states, many big tanneries and shoe factories are now operating in the middle west and some in the far west. In addition to shoes, much leather is used in manufacturing sports jackets, gloves, luggage, purses, belts, decorative articles, in upholstering furniture, and in binding fine books. Besides, there are many strictly industrial and mechanical applications for which leather still is the best material available. To name but a few: hydraulic packings, washers, gaskets, machinery belting, and many kinds of straps. Among the by-products of the industry is hair, which plays an important role in textiles, carpets, insulation, felt, etc. Others go into fertilizer, while parts of hides that are unsuitable for leather are made into glue and gelatin.

In the past,the United States has imported much raw material, both hides and tanning supplies. Though we still get many goat skins and other hides from abroad, some kinds that were formerly imported are no longer obtainable. As a result of this world scarcity and the greater cattle kill in this country, we have latterly exported a small percentage of our production.

Excepting alligator, lizard, and snake skins, which are prepared to provide exotic-appearing leathers for milady's shoes and handbags, most of the hides used in the leather industry are by-products of the packing industry. Much of the goatskin and some cattle hides from distant lands are dried and shipped in that condition. Hides from Europe and North and South America are now sold mostly in a wet-cured state after having been salted carefully to preserve them. As is common with all natural products, the material varies in quality and condition, and careful selection and sorting is therefore required to obtain the one best suited for a given type of leather.

Many other kinds of skins are used, usually in rather small quantities and for specialized purposes, and these are collected from all over the world. This is also true of tanning materials, many of which are shipped to this country in the raw state to be refined while others are partially prepared in the lands of their origin and arrive in crude form for further refining. Included among these are a great variety of organic and inorganic chemicals, natural vegetable tanning materials, as well as vegetable, animal, and mineral oils and greases. Of the latter, some of the more common ones are cod and other fish oils, neat's-foot oil, castor oil, linseed oil, tallow, lanolin, and numerous petroleum products. These give added strength, flexibility, durability, and beauty to leather.

In a general way, the tanning process may be said to consist in washing or cleansing the hides; removing the hair with lime or some other agent which dissolves or loosens it; dissolving out the lime; and putting the hides, which are then chemically similar to pure gelatin, into weak tanning liquors either in drums or vats and gradually strengthening the liquors as the tannin is absorbed until a completely tanned piece of leather is obtained. After this is done, the skins are usually washed or cleansed and treated with the oils or greases and the dyes necessary to give the finished leather the physical properties and appearance desired. Many kinds of leather go through a great number of steps during the operating cycle before the material is ready for use.

Sole leather for shoes is the hardest and firmest of the types produced. It is finished in such a way as to withstand abrasion, and must be sufficiently flexible to be comfortable and yet firm enough to protect the sole of the foot from bruises or cuts. While materials such as rubber and plastic can be used for shoe soles and are in some ways advantageous, particularly from the standpoint of durability, people generally prefer leather-soled shoes because they are lighter and do not feel so hot. The next of the heavy leathers is the mechanical type which is stronger and much more flexible than sole leather. It serves as belting and has hundreds of other industrial applications.

Then there are the softer harness and saddlery leathers which must be tough, durable, and nice-looking. After that come many lighter kinds, mostly cowhide, used for upholstering and for heavier shoe uppers. These leathers are nearly always dyed and treated to give them a fine appearance, as well as durability. Patent leather for shoes and fancy articles also is made from the same raw material

but is coated on one side with a shiny, flexible enamel. Bag, case, luggage, and strap leathers likewise come from lightweight cattle hides and are often embossed or finished with a grained pattern.

Calfskin is still lighter and is especially suitable for fine shoe-upper leather and for gloves. It is handsome and will stand a lot of hard wear. Some of the finest-quality leathers are calfskin. Occasionally the flesh side is finished with a suede or even nap which gives a dull but very attractive surface with a silky feel. These materials are popular for certain kinds of shoes, for handbags, and particularly for garments because they are soft. Goat and kid leather, or Morocco as it used to be called because the Moors were the first to produce it, account for a large proportion of our shoe uppers, as well as for many other types of fancy, light leather that must be strong, flexible, and tough. Gloves and the linings of certain shoes also are made of kid.

Sheepskin is said to have a greater number of applications than almost any other leather. There are many different grades, thicknesses, etc., and they are manufactured into a wide variety of articles, including gloves, clothing, handbags, hatbands, and parchment. Some of the hides are finished with a short length of wool still adhering to them. This form, called shearlings, makes excellent warm linings for windbreakers and coats and was used in large quantities by the armed forces.

Human health and comfort requires covering for the body that will not only give sufficient warmth and protection but will also allow ventilation so that the natural heat and moisture from the skin will be carried off when one is exposed to cold and wind. Garments and shoes of properly tanned leather offer great protection without being too tight, and as the material "breathes," it permits the passage of a limited amount of air, thus insuring body comfort.

Wide World Photo

PROTECTIVE GLOVES

A wartime scene of a "burner" cutting one of the steel plates by which a newly built ship is released for launching. He is wearing leather safety gloves.

There is another class of leather known as fancy leather that is produced from many kinds of skins, usually thin, and is suitable for pocketbooks, sewing kits, jewel cases, collar bags, etc., that are decorated by tooling. Much horsehide leather goes into the making of sporting goods such as baseballs and mitts, and pigskin is sometimes used for similar purposes.

In recent years, great advances have been made in the application of scientific methods and the control of materials, with resultant improvements in the quality, uniformity, appearance, and durability of leather for every purpose. During the war, all the governments concerned recognized leather to be one of the vital basic products, and the raw materials available were allocated principally for conversion into army leathers and into mechanical leathers needed in the manufacture of essential supplies and equipment. It has been stated that our armed forces used more than 500 items whose main component was leather, as well as thousands of other articles that required a certain amount of leather to achieve the best results. The army purchased 249 sizes of shoes of 32 different types for all kinds of combat and climatic conditions. Millions of special retan leather laces were made for shoes for ski troops, paratroopers, and for other duty of a severe nature. The greatest care was exercised that our men might be properly shod and that all material would be the most serviceable that could be devised.

While a mechanized army does not need saddles and bridles it does have to have a great variety of leather products such as holsters, bags, and straps. Leather was used for making instrument and equipment cases wherever protection against shock and strength and durability were of vital consideration. On shipboard the Navy put rigging leather to hundreds of services; and, because leather is light, strong, and fairly fire resistant, it was found to be the best upholstery material on battlecraft and airplanes.

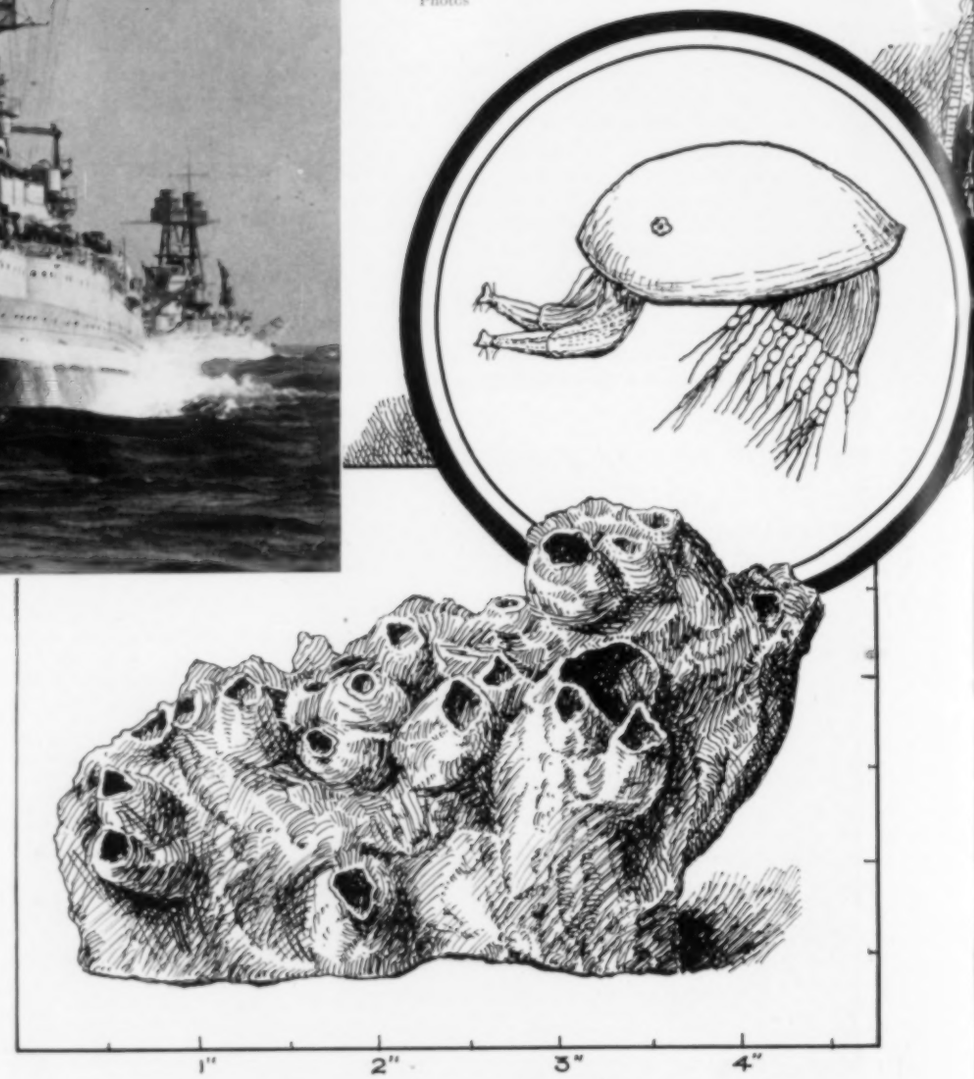
Leather has its romantic or thrilling applications. Think for a moment of mountain climbing and of skiing, that most fascinating of winter sports. In addition to a particular type of shoe of the best leather, a good deal of the harness and the ski-pole straps consists of leather, as does the lacing for the disk at the bottom of each pole to push against the snow. Snow shoes, too, are laced with rawhide thongs, and the men who run the dog-team races in the North Country want only the best quality of leather laces for their shoes and special thongs to tie their loads for journeys of hundreds of miles in bitter weather. Leather of the same kind has proved its worth in Arctic and Antarctic expeditions.

A second article in the November issue will describe more fully the important part leather plays in the mechanical and industrial life of our nation.

Baffling the Barnacle

Robert G. Skerrett

U. S. Navy Photos



FOES OF NAVAL SPEED

With shiny, clean hulls, the battleships at the top-left cleave the seas with a minimum of resistance. The sketches illustrate some of the forms of marine life that foul bottoms, thereby slowing vessels down and requiring the expenditure of more fuel than normal to drive them through the water. Just above is a cluster of barnacles removed from a ship that had been in the Pacific only four months. In the circle is seen the cyprid larva of one type of barnacle while in the free-swimming stage during which time it seeks a surface to which it can anchor. It is then of microscopic size but, once attached, grows and receives an enveloping protective shell. The cross-sectional sketch at the top shows a barnacle within its shell. These animals accumulate in clusters that may reach a thickness of from 5 to 9 inches in a few months. It is estimated that 300 tons of them are sometimes attached to a large vessel. At the top-right is the U.S.S. "Mount Olympus" in dry dock and undergoing cleaning of her bottom. The hull had been sandblasted and coated with a corrosion-protective phosphoric-acid solution and was receiving the first of several coats of antifouling paint when the picture was taken.

BARNACLES, seaweed, algae, and mussels instinctively attach themselves to any immersed surface that offers a place of lodgment when any of these organisms are in their early free-swimming or current-swept stages, and then they grow and multiply. These forms of marine life are more abundant and more rapid in their development in sea regions where the warmth and the salinity of the water are relatively high.

Japan's naval strategists were fully aware of the habits of these organisms and expected them to serve as unwitting allies in hobbling our naval vessels in the western Pacific. Mobility at designed high speeds and the most effective and economical use of fuel are of the utmost importance when ships are in zones of conflict and remote from their normal bases. Our naval strategists were able to give the enemy more than one staggering surprise, and research in paints and plastics contributed handsomely to that end. The story of how that was made possible would probably not yet be available to the public had not the Navy recently revealed what it was about to do in preparing a fleet of more than 2000 combat vessels for placing in protected reserve. The bottoms of all these steel ships are to be coated with a hot, poisonous, plastic paint capable of killing barnacles, or any other marine organisms likely to cling to the underwater surfaces. And still more astonishing was the announcement that the treatment would be effective for five years in salt water and for more than fifteen years in fresh water.

Some idea of what marine organisms can do in a few months to foul a vessel's bottom and to cut down her speed was shown in the case of a small iron ship—the *U.S.S. Ranger*—built about 1876. That vessel had a displacement of 1020 tons and was 175 feet long on her water line—diminutive compared with a present-day destroyer. The *Ranger*, after being dry-docked and painted, was detailed to do surveying work on the coast of Lower California and left the Mare Island Navy Yard in November, 1886.

The following July she returned to Mare Island in a badly fouled condition, which was later officially described as follows:

"The *Ranger* was docked at Mare Island last October, about four months after her return from the coast of Lower California. Coming up the harbor to the Navy Yard, she is said to have presented a remarkable spectacle. Along the ship's side, at the water-line, was a thick growth of bright green seagrass, from a few inches to a foot in length, while kelp in stringers and in bunches up to 6 feet in length trailed alongside and astern. The water in the Mare Island straits is nearly fresh, and in a few weeks the kelp dropped from the bottom of the vessel; but when docked, there was still a large quantity of barnacles, some as deep as 1½ inches, and a thick growth of marine vegetation with clusters of mussels to an average depth of 4 inches. Taking at random an area of 16 square feet, and scraping off and weighing this marine vegetation, barnacles, and mussels on the day succeeding the docking, the total weight of the entire surface of this stuff was computed at 12 tons, a weight sufficient to increase the draught of the ship nearly 1 inch. What this encumbrance cost the vessel in speed and coal may be seen from the appended tables of the relative speed and consumption of coal with a clean and a foul bottom."

Clean Bottom		Foul Bottom	
Speed per Hour	Coal per Hour	Speed per Hour	Coal per Hour
Knots	Pounds	Knots	Pounds
6.0	400	6.0	850
6.6	630	6.7	1200
8.1	900	8.2	1980
10.2	1250	10.0	3240

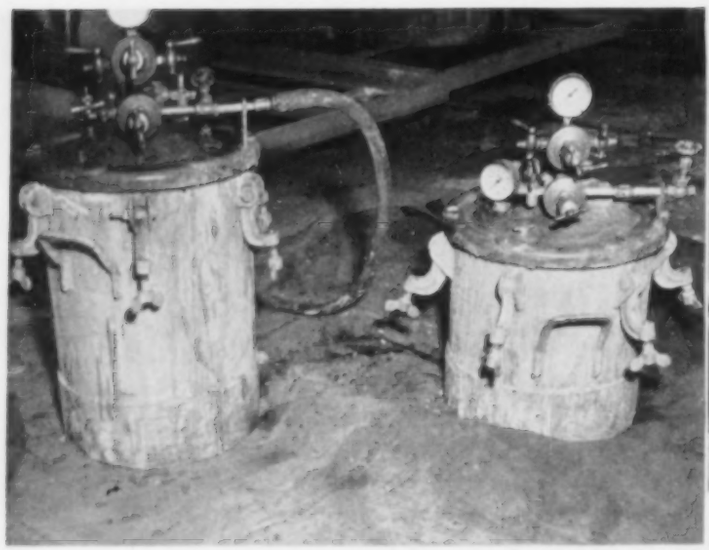
In the Pacific ports of Mexico and South America our naval ships then had to pay $20 (in gold) per ton for coal. The warm waters visited by the *Ranger* promoted rapid accumulation of marine organisms. The same fouling is somewhat greater in the warm waters of the southwestern Pacific where our fighting craft and supply vessels were recently active against the enemy for the better part of three years.

Our New Navy, consisting of ships of steel, was started in the early "eighties," and when the first of those modern vessels was put overboard, salt water soon corroded the steel and caused serious "pitting" of the hull plating just above as well as below the load line. The surfaces of the bottom plates, their edges, and some of the rivet heads were badly corroded—the pitting causing cavities ⅛ inch in depth. This action was especially harmful in cases where the skin plating had a thickness of only 7/16 inch. At that time the Navy, just before launching, gave each vessel three coats of paint composed of two-thirds red lead and one-third white zinc; and when dry-docked, after launching, the bottom was again painted with a proprietary anticorrosive paint. What happened to one of the craft subsequently while in commission for less than two years was thus reported: "The ship was again placed in dock and after the bottom was thoroughly scraped to remove barnacles and grass there remained no sign of the patent paint; but the red lead still adhered to about one-quarter of the surface." The bottom plating and the rivet heads had suffered from considerable pitting. Such was the status of anticorrosive paints at that period. Efforts to produce both anticorrosive and antifouling paints followed later.

In 1887, the then heavily armed cruisers *U.S.S. Atlanta* and *U.S.S. Boston*, sisterships, were given their acceptance trial trips. The *Atlanta* made a 6-hours' run in April under loaded draft conditions and scored an average speed of 15.5 knots with her engines developing 3345 ihp. The following September, the *Boston*, with her bottom fouled while lying in port for more than a year, was able to make an average speed of 13.8 knots when loaded to the same draft as her sistership and for that performance her engines had to develop 3780 ihp. Fouling cut 1.7 knots from the *Boston's* speed. She also had to burn more coal per hour, of course, and her boilers and engines were severely taxed to develop 435 ihp. more than the *Atlanta*. If the two vessels had been fighting each other, the *Atlanta* would have enjoyed a decided tactical advantage.

Nearly half a century ago Sir William H. White, an eminent British naval constructor, wrote: "Frictional resistance is the most important element of the total resistance of most ships, and in well-formed ships moving at moderate speed it constitutes nearly the whole of the resistance." Model experiments confirmed that pronouncement and established the coefficients of resistance for various surfaces. The coefficient for smooth paint is 0.01; that for a moderately fouled surface is 0.019, and for a barnacled surface it is 0.055.

In his classical book, *The Speed and Power of Ships*, the late Rear Admiral David W. Taylor, USN., an internationally known member of the Construction Corps of the service, developed curves of shaft horsepower for ships at various periods after dry-docking and used as examples a 32,000-ton battleship operating off the coast of California and a 310-foot destroyer maneuvering in the North Atlantic. After six months out of dry dock, the reduction in maximum speed of the battleship was indicated at just over one knot and the shaft horsepower required at 20 knots was 25 percent greater than with a clean bottom. For the destroyer, after six months out of dry dock, the reduction in maximum speed would



ANTICORROSIVE PAINT

Before poisonous antifouling paint is applied to a ship's bottom, the cleaned metal surface is given an anticorrosive protective covering. This is mixed in a 65-gallon tank (right) by an impeller operated by a Multi-Vane drill mounted on top of the tank. A worker is drawing off a bucketful of the paint, which is then placed in 5- and 10-gallon holders (above). From the latter it is delivered to the spray guns by air pressure.

be about 2 knots, and to maintain a speed of 20 knots it would be necessary to increase the shaft horsepower 50 percent.

These data make it clear that fouling increases the fuel to be burned and lowers the range of action on any given fuel supply; and when developing the shaft horsepower at the highest attainable speed with the bottom fouled, the propelling plant is subjected to stresses that are likely to hasten mechanical impairment or breakdown. The problem of maintaining a steel vessel's bottom in proper condition for sea service is of a twofold nature: the plating must be safeguarded against damaging corrosion as a matter of structural security, and fouling accumulations of marine organisms that hamper mobility and increase operating costs must be arrested and, if possible, prevented.

Since the appearance of the first seagoing ship built of iron, maritime nations and men have struggled to devise means of checking corrosion and fouling. In the interval, thousands of patents have been issued for various paints either to prevent corrosion or fouling or both, but up to 1889 few if any of them were at all successful. Our own Navy gave every encouragement to inventors and paint manufacturers seeking to be of help to our fighting fleet and to merchant vessels. Paints for which claims were made were willingly tested at two of our Navy Yards.

Some progress was made from time to time, but in most cases the paints were only a partway remedy and effective for comparatively short periods—the ships needing to be dry-docked frequently for cleaning, scraping, and repainting their bottoms. This procedure continued until shortly before the recent war when the Navy, with the collaboration of the Edgewood Arsenal of the Army, sought to discover the ingredients of an Italian formula widely used for years and generally known as "Moravian paint"—a hot plastic composition that had given generally excellent results in checking fouling. But chemists could not determine by analysis the composition of the foreign product. However, the quest was informative because it indicated the general nature and the protective value of a thick plastic matrix as a carrier of toxic ingredients that apparently deterred the attachment and growth of fouling marine organisms.

Using phenol-formaldehyde resins as a plastic matrix, paint research laboratories at the Mare Island and Norfolk Navy Yards started independent investigations stimulated by the rapid fouling of our naval ships engaged in peacetime maneuvers in the Central Pacific during several years in the 1930's. The Moravian paint, applied to some of the bottoms for comparative purposes, had to be heated above the boiling point of water. That fact added difficulties to its use, and there were other drawbacks—notably high costs. According to Capt. Henry A. Ingram, USN., at one time head of the Research and Standards Section of the Bureau of Ships, service performances were "generally untrustworthy" in the cases of the American substitutes.

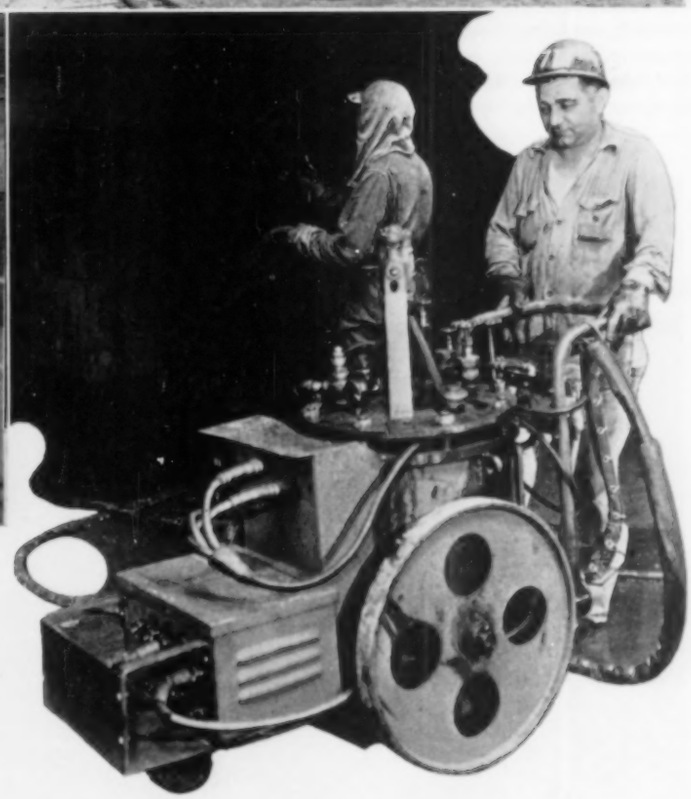
Undeterred, the scope of the investigation was widened. The Industrial Test Laboratory at the Philadelphia Navy Yard took up one phase of the work while Columbia University, New York, and the National Defense Research Committee took over other divisions of the subject. Basic studies on the fouling phenomena and the relative effectiveness of various toxic agencies were undertaken at the Woods Hole Oceanographic Institution and at the Navy Biological Laboratory at San Diego, Calif. Further, a new testing station, operated by the University of Miami, was established in Florida on a tidal inlet some miles south of Daytona Beach where the water temperature ranges from 65 to 80°F. throughout the year and where the growth of fouling marine organisms is heavy the year round. In addition, a number of members of the National Paint and Varnish Manufacturers' Association and of the American Coordinating Committee on Corrosion aided with their advisory services. By that time the battle against the barnacle and its associate troublemakers was attaining formidable proportions. Incidentally, certain of the sea organisms were studied at close range in the laboratory because more had to be known about marine animal and vegetal growths before they could be balked of their habit of attaching themselves to a vessel's bottom.

Among those greatly helping in the quest of a hot plastic coating superior to the Moravian paint was Capt. Antonio S. Pitre, then a lieutenant commander in the Construction Corps of the Navy and

attached to The David W. Taylor Model Basin, Carderock, Md. From there he was ordered to the Mare Island Navy Yard, where a group of four destroyers was assigned for testing some experimental paints evolved by the Navy in collaboration with the Edgewood Arsenal. The value of each antifouling plastic coating was determined after service on the bottoms of the vessels. Captain Pitre conceived various equipment capable of applying the experimental paints so as to produce a smooth and continuous film. Among these was an electrically heated pneumatic apparatus for spraying hot plastic paints that proved its worth in coating the underwater areas of fifteen craft of different sizes and types. In some of the paints mercuric oxide was the toxic ingredient. That chemical is notably effective but expensive, and became prohibitive later when it was more urgently required for munitions. Captain Pitre found out how he could utilize copper instead of mercury and so reduce expense.

In the days of wooden ships, the heavy bottom planking was covered with thin sheets of copper nailed in place to arrest the teredo—the shipworm that can bore into the heaviest timbers and so honeycomb them as to cause them to crumble or collapse without warning. The copper also checked accumulations of barnacles and marine vegetation. One widely accepted explanation for this is that the copper sheathing exfoliates in extremely minute films in the presence of sea water, and any marine organisms that may have accumulated in ports of call are thus released once a craft is in motion again. The sweep or pull of the passing water detaches the growths and leaves the metal surface bright and clean; and in that condition the coefficient of friction or resistance is even lower than that of smooth paint.

The problem with respect to modern plastic antifouling paint has been to find a cuprous ingredient that could be thoroughly distributed throughout the plastic coating and that would gradually leach out under the action of sea water so as to exert its toxic effect over a prolonged period. It was necessary that the paint be sufficiently permeable to assure the



SEQUENCE OF PLASTIC PAINTING

Received in drums, the plastic poisonous material is broken into pieces and delivered to a steam-heated 200-gallon melting tank (top). At the top of the tank (above) is mounted an air-driven Multi-Vane drill that turns an impeller to stir the melted paint. When sufficiently fluid, it is drawn off into containers for filling electrically heated pressure kettles that supply the spray pistol (right). Compressed air forces the paint from the kettles to the spraying apparatus through electrically heated hose.

toxic content reaching the surface of the paint where it would meet and kill any marine organism seeking to attach itself to a vessel. This action differs from that of the old copper sheathing which, as already mentioned, was in the main a mechanical one. Today, the new bottom paints, formulated primarily for our naval ships, poison the parasites when in their elementary or larval stages and before they can secure a foothold or develop the physical protection nature gives some of them in the form of shells or shell-like coverings.

But these modern plastic coatings do not entirely solve the problem of protecting a craft's bottom because the antifouling characteristic plays no part in safeguarding the plating from corrosion, especially in the presence of sea water. Therefore, the paint must assure a twofold defense—against fouling and also against structurally serious corrosion. To this end, separate coats are applied to the bottom: the first ones are capable of minimizing or preventing corrosion, and the succeeding ones are of antifouling plastic paint.

The whole subject of suitable anticorrosive and antifouling paints is a somewhat involved one and cannot be dealt with here in any detail. As should be apparent, many men of many minds and a vast amount of research have in latter years produced results of great value, and the quest is likely to continue. Betterments are even now registered, and decidedly efficient cold plastic paints have been evolved for some services. Further, the methods employed in making the various paints ready for use and then actually applying them have been steadily improved. Much ingenuity has been devoted to adapting already existing equipment or to designing others that make it possible to do the needed work well and more rapidly. For the present purpose let us describe how the new paints are handled and applied to the bottoms of vessels at the New York Naval Shipyard.

The first operation after a craft is drydocked is to clean her underwater skin of fouling accumulations and, if need be, to bare the steel plating to bright metal to free it of all traces of corrosion. This is essential in order to provide a surface that will assure an intimate bond between the steel and the base coat of the succeeding films. The anticorrosive paint must be impermeable so as to form an effective barrier between the steel plating and the outlying coats of antifouling plastic paint containing copper. This separation is necessary because the copper would function as an element if electrolytic action were induced should salt water act as a linking electrolyte between the copper and the steel. Under those circumstances the steel would undergo more or less rapid deterioration.

In years gone, spades and shovels were used to scrape off the fouling accumulations on an iron or steel vessel's bottom, but the up-to-date way is to do the job by sandblasting, which does the cleaning thoroughly and rapidly. At the New York Naval Shipyard a wet sandblasting process is employed and special apparatus has been designed so that silica sand, with just sufficient water to reduce dust formation to a suitable degree, can be expelled from the blasting nozzle with ample velocity to do its abrasive work. The sandblasting machine is susceptible of adjustments that will quickly adapt it to variable requirements.

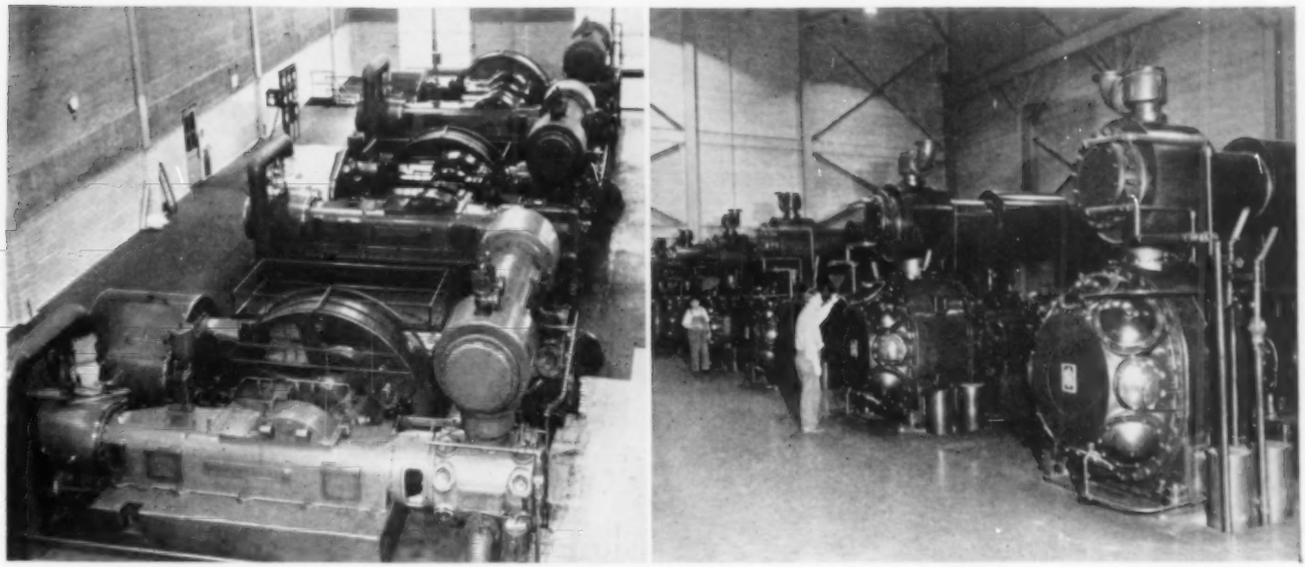
Wet sandblasting was adopted to safeguard the health of the operators and also to minimize the spread of air-borne dust on shipboard where it might impair delicate instruments. Any silt from the sand that may remain on the bottom plating after blasting is washed down with fresh water, and it may be desirable to hasten drying of the hull with streams of air. As soon as the cleaned surfaces are dry, dilute phosphoric acid is sprayed over the bared metal. This yellow film is effective in preventing any rusting that might occur between completion of the sandblasting and the laying of the first coat of anticorrosive paint. In fact, the phosphoric-acid coat, if properly applied, will protect the underlying steel for fully a month should painting be delayed. The phosphoric acid is said to cause a reaction through which the metal surface is covered with a film that affords a helpful anchorage for the base coat of the anticorrosive paint.

The Navy's anticorrosive paint is produced in accordance with a secret formula. The present practice is to apply the first coat by brush and the second and third by pneumatic spray guns. The paint is prepared for use in a large tank placed on the floor of the dry dock and is stirred by an air-operated impeller. As needed, it is tapped off into portable 5- or 10-gallon tanks in which it is agitated by means of compressed air, which also serves to force it through lines that supply the spraying pistols.

The hot plastic antifouling paint does not reach the necessary fluid state until it has been heated in excess of 300° F. and presented some difficulties in the earlier

SANDBLASTING

While a ship is in dry dock for repainting of her bottom, a workman (above) cleans her chain cables with a wet sandblast. Breathing air is supplied to his respirator through the smaller of the two hoses shown. Air pressure feeds the moistened sand to the nozzle from the apparatus at the left.



AIR COMPRESSORS

These machines at the New York Naval Shipyard have a combined discharge capacity of approximately 46,000 cubic feet of air per minute at 100 pounds pressure. All were made by Ingersoll-Rand Company. At the left are shown three steam-driven Type XPV units that were set up prior to World War II. At the right are four Class PRE machines each driven by a 2000-hp. synchronous motor centrally located between two frames which have a compression cylinder at either end, or four in all. The high-pressure cylinder beside which the near man is standing has an inside diameter of 23½ inches. The low-pressure cylinder in the foreground is 38½ inches in diameter. These compressors furnish air for many uses around the yard, including the operations described.

days of its testing and service adoption. The plastic substance, which has the consistency of asphalt, reaches the Navy Yard in thin sheet-metal drums, which can be readily opened with an axe. The stuff is then broken into lumps that are placed in an open steam- or oil-heated kettle, where it is first melted. The broken pieces have the appearance of fractured brown sandstone, are somewhat porous, and the surface is slightly yielding when pressed with the hands. Scattered through them are flecks of green copper oxide, the distribution of which is more in evidence on the outer surfaces.

During melting, the material is stirred by an impeller that is driven by a Multi-Vane pneumatic drill. When sufficiently fluid, it is transferred to an electrically heated pressure kettle, from which it is forced under air pressure through an electrically heated hose that is connected to the spray pistol. The kettle is mounted on wheels so that it can be moved about to suit the changing position of the sprayer. Technicians in the paint shop at the New York Naval Shipyard have designed spray-gun heads that can be used either with the anticorrosive or with the hot or cold plastic antifouling paint. In any case, the paint is fed to the spray nozzle in a way to avoid any clogging of the apparatus. Further, the same experts have devised a light and simple extension arm for the spray pistols so that it is possible to cover a wide area from a single station. The same equipment enables an operator to reach up and into bottom outboard connections or main inlet and discharge openings through which sea water for condensers, fire mains, and sanitary purposes is drawn into and expelled from a ship. These bottom openings have frequently been fouled and clogged by mussels.

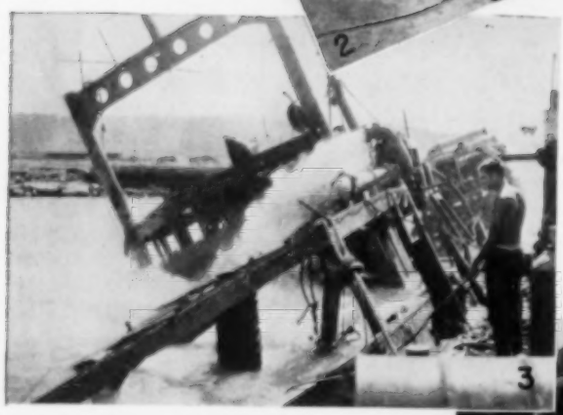
The sprayers of the hot plastic must be rugged men and skillful operators. They must hold their guns steady at a distance of from 18 to 24 inches from the surface, and they must do this despite the high temperature of the material. Should they stand too close to the ship's bottom, the paint will not solidify instantly on contact with the surface but will slide and sag. On the other hand, if the pistol be held too far away from it, the paint will partially congeal before it strikes the surface and produce an objectionably rough coating.

To protect the operator, he wears a mask and other coverings for his head, neck, and shoulders, and his hands are shielded by asbestos gloves. He is further hampered by the extra-heavy hose that delivers the paint to the gun, and it is fatiguing to support some of the weight of the hose and to hold the spray gun in position. Even so, properly selected and trained men can apply the paint rapidly and efficiently with the aid of the facilities now available. For example, a 1600-ton destroyer could formerly be bottom-painted in one day with 20 men at work on each side of the craft. Now four sprayers using two machines can do a similar job in the same length of time.

The hot plastic antifouling paint is required to have a thickness of at least 30/1000 of an inch applied in three coats, and a gallon will cover about 40 square feet (most of the marketable antifouling paints will cover something like ten times that area). The greater thickness enables the plastic paint to give better and longer protection and to carry a greater measure of toxic content that will slowly, but continuously, leach out to the surface and poison marine organisms seeking to attach themselves to a vessel's bottom. The cold plastic poisonous paints successfully evolved under the leadership of naval men have advantages under some conditions. In warm and mild weather they do not have to be heated to make them ready for spraying—heating is needed only in cold weather when the host plastic poisonous paints are much more difficult to use and to apply satisfactorily.

To explain better what has been achieved, let us abstract again from Captain Ingram's paper published early in 1944 in the *Journal of Applied Physics:* "Vessels can remain out of dry dock as long as eighteen months with inconsequential reduction in speed or increase in fuel consumption due to marine fouling. . . . Fleet demands for fuel are appreciably less—perhaps 10 percent; fewer tankers are needed to service the fleet; and corrosion of ship hulls is notably reduced. The cost of the paint has been halved." The latter item is of economic importance, and especially interesting to commercial operators who must figure closely when competing with keen rivals of other maritime nations.

At long last hampering sea organisms, and the barnacle in particular, have been brought under control if not yet entirely beaten.



Air Under the Sea

Thomas McConlogue

DURING World War I, salvage as a vital factor in warfare was not held in the same regard as it was during the past conflict; in fact, the United States and Great Britain were the only countries that had laboratory facilities in this field and we confined ourselves to limited and basic research in connection with jobs of comparatively little importance. With the outbreak of World War II, the Army and Navy were confronted with problems that could be solved only by a large and efficient ship-salvage force. Owing to the speed and destructiveness of modern warfare, the mountainous supplies required to maintain the fighting fronts, and the great expanses of the theaters of operation, it was imperative that harbors, beaches, and docks be kept clear of obstructions to insure smooth and speedy landing of men and matériel.

Caught at Pearl Harbor, the Government found that personnel skilled in underwater work faced a hopeless task because of its insufficiency in numbers and knowledge of major salvage work. Overnight, the original laboratory at Washington, D.C., was quadrupled in size and the force increased accordingly. Diving schools sprang up at Norfolk, Va., Quonset Point, R.I., Pearl Harbor, Hawaii, Tiveron, Calif., and at Pier 88, New York City. That in the latter place was conducted in connection with the largest individual salvage job ever attempted—the raising of the fire-wracked French liner *Normandie* which became a tragic casualty while undergoing transition into a troopship.

These schools ran regular courses and produced many divers and new and faster methods of salvage largely through the extensive application of pneumatic tools, which proved to be highly efficient for operations underwater. While personnel and tool uses were being developed, special craft for this work were under construction in our shipyards, and at the end of the war upwards of 100 vessels were commissioned in the Navy to clear harbors and beaches from Cherbourg to Okinawa and to repair damaged ships far from permanent bases of operations.

Outstanding as an example of what was accomplished in this field was the clearing of Naha Harbor on the Island of Okinawa, for it gives a concise, overall picture of one of the big salvage jobs that had to be tackled. On the morning of May 7, 1945, the *U.S.S. Anchor*, under the command of Lieut. Commander

Richard C. Cruise of Boston, Mass., slowly picked her way through the heavy overcast toward the fingerlike island, and soon the narrow entrance of battle-torn Naha Harbor took form ahead. A small auxiliary was then lowered over the side to precede the vessel for the purpose of taking soundings and insuring safe passage into the inner harbor.

Once inside, a scene of utter chaos met the eye. Masts and superstructures of Japanese ships protruded in every direction from the foul surface of the water. The *Anchor*, because of her size, had to move with utmost caution, for the constricted channel was literally choked with sunken craft. The docking area presented a tumbled mass of timbers and masonry, except for one small stone pier that was unharmed and looked incongruous among its demolished neighbors. There the *Anchor* tied up and remained until the harbor was cleared and open to shipping. She formed the nucleus of the salvage force.

Meanwhile, American vessels in the outer harbor could unload their cargoes only through the medium of finger-docks made up of connected pontoons stretching seaward in boxlike formation. This procedure, however, was very slow by reason of the fact that the large ships could not use the temporary facilities because of the shallowness of the water in which they lay. The cargoes therefore had to be unloaded into small landing craft for transfer to the finger-docks, where the freight was piled on trucks for shore transportation.

Nine vessels of from 5000 to 8000 tons had to be removed, or enough of their superstructures blasted off to allow a clearance of 20 feet at low tide for shipping. In the five weeks that followed, seven of the vessels were salvaged, towed out to sea, and resunk. The two others were so badly damaged that the only recourse was to blast away the upper works by the use of dynamite and T.N.T. In the operations at Naha Harbor, pontoon barges were utilized as a matter of convenience to carry compressors, electric welding machines, acetylene, hydrogen and oxygen bottles, much salvage gear, and lines for pumps, the latter being secured to the exposed part of a wreck whenever possible.

The first step in raising a sunken ship is to send divers down to examine her thoroughly, to chart all points of damage, and to determine the best method of salvage. In addition to verbal reports, it is of value to make sketches of the underwater damage on a slate, with actual measurements wherever feasible. Several lines of procedure should be drawn up so that if one fails another is available. Divers' work, like any other difficult task, can be more efficiently performed when the operations involved have been well studied and planned and each man is assigned a given job. As much as possible of the preliminary work should be done by the surface crew in order to reduce work on the bottom to a minimum. Deck crews also should plan ahead. Their most important task is to keep the compressors in good condition and to see to it that the divers have an adequate supply of pure air—at least 4 cfm. per man.

Operations usually begin at the bow peak tank, which serves to stabilize a ship in a rough sea. If there are any holes in it, they are properly patched and an air fixture and hose are attached for the purpose of blowing (a term in salvage that means replacing water in a confined space with the positive buoyancy of compressed air). The entire forward deck is then made airtight. All holes are covered with wood, rubber, and cement, the latter being applied by a compressed-air gun which is used expressly to seal hatches or other openings with a special cement that normally hardens underwater in approximately 24 hours.

The gun has to be thoroughly cleaned after each application. It is composed of a large steel cylinder having a cement-outlet hose on the bottom and an air-inlet hose on top and is further equipped with small petcocks in the cylinder wall to ascertain the level of the contained material. The cement is forced under pressure of the air to the desired location through a length of hose. In sealing underwater spaces it is necessary to have them suitably protected by canvas or other material to prevent water currents from washing the cement away as it is deposited.

The rubber-backed wooden patches are secured by six to eight J-shaped bolts, depending upon the size of the opening. The holes for these bolts are generally drilled with an air-operated tool, for this is the fastest and easiest method. After every use, the drill is submerged in a light penetrating oil because salt water has a tendency to corrode its working parts. Sometimes, however, a metal patch is needed. In that case, velocity power tools are utilized. Like pneumatic tools, they are well adapted for underwater service where the operator is physically restricted. Of special value in salvage work is the velocity power cable cutter, which is capable of severing wire up to 1 inch in diameter.

Velocity power tools obtain their actuating force from powder cartridges similar to those made for rifles except that the cartridges for the former contain only powder. The projectile, or moving member, is an integral part of the tool, which is a quick means of attaching steel plates because it both drives studs in the base and punches the holes in the patch plate through which the studs are inserted. The plate can then be attached to the base by nuts, after which welding may be done if a more permanent attachment is desired. In addition to driving studs and punching holes, the velocity power tool may be employed to remove rivets by

NAHA HARBOR OPERATIONS

So that our vessels could enter, salvors went into action without delay to clear the harbor, choked with Japanese shipping sunk by American bombs and gunfire. 1– A Jap merchantman, with hull patched and mountings placed for the dewatering pumps. 2– A closer view, showing damage done by bombs. 3– The pumps begin to discharge water from the hull. 4– the "U. S. S. Anchor" raising a vessel that was blocking a dock. 5– A Marine guard and sunken shipping. 6– American vessels grounded by a typhoon. The tanker in the foreground had to be removed as it was partially blocking the harbor entrance. 7– A Jap tanker-barge that was raised solely by displacing the water in her hull with compressed air. 8– Blowing up an unsalvageable craft.

U. S. Navy Photos

MOMENTS WITH DIVERS

Donning underwater dress is no small chore. At the upper left, two attendants are helping a diver into a much-patched outfit. The other views show divers about to descend. The one pictured above holds a lighted hydrogen-oxygen torch with which to cut away parts of the metal superstructure of a sunken ship.

changing the type of the projectile head. This method, however, was found to be impractical because it was often necessary to reload in order to complete removal. Usually, a pneumatic tool was preferred because it works steadily.

All ventilators, steam pipes, etc., are plugged in the same manner as the holes. That done, divers examine the hull for seam-splits. If any are found, a small air hammer with a calking tool attached packs the wedge-shaped openings, usually with oakum, thus preventing further leakage.

In the case of jagged holes, it is frequently necessary to remove some metal so the patch will lie tight against the hull. This is done by underwater cutting equipment—either by air-oxygen-hydrogen or oxygen-electric torches. In the former, the flame is protected by a bubble of compressed air, which also prevents the water from cooling it. But, while the gas torch gives a hotter flame, the slower-working electric-arc torch is more adaptable and dependable for subaqueous use in that it will cut all commercial metals and no adjustment has to be made after a descent, regardless of the depth at which a diver works. The air-oxygen-hydrogen torch is unsuitable for non-ferrous metals and must be adjusted to control the length of the cutting flame which, in turn, is dependent upon the external pressure or depth of water. However, for cutting hard or thick steel, the gas torch has proved to be by far the most efficient.

At a submergence of 100 feet, the air-oxygen-hydrogen torch needs 135 pounds of oxygen, 115 pounds of hydrogen, and compressed air at a pressure of 115 pounds, these requirements varying slightly with changing depth. The tip of the electric-arc torch is supplied with oxygen at a pressure of 60 pounds per square inch in excess of the water pressure at the working level. It is fed through a hollow, heavily coated electrode and serves

to increase the flame temperature and to form a gas bubble in which the arc burns. Current up to 300 amperes at 50 to 60 volts is usually used to maintain the arc.

After the forward section of a sunken ship has been made airtight, the stern section is similarly secured. With that done, everything is in readiness to start the pumps. From four to six 10-inch low-pressure units, spaced equally fore and aft, are generally needed to salvage a vessel of 8000 tons. If the ship is in water not too deep, a prefabricated cofferdam is put into use, fastened to the after-hold hatch, and sealed by means of a cement gun. This affords a clear view of progress as pumping proceeds.

One vessel in Naha Harbor, a Japanese tanker, was raised solely by means of compressed air. This method was decided upon when divers, engaged in patching her damaged areas, discovered that she consisted of two separate tanks. Accordingly, one ¾-inch hole was drilled and tapped in each tank, which was then connected by an air fixture and a length of hose to the air receiver of an Ingersoll-Rand Class ES compressor. Two holes, 3 inches in diameter, were next cut in the bottom of the respective tanks to allow the water to escape as the air, with its overbalancing pressure, entered the tanks. These holes were patched and made tight as soon as positive buoyancy had thus been restored.

The removal of 182 sampans and fishing junks, ranging from 10 to 70 tons, was facilitated by two large barges provided with 80-ton A-frames having pulleys reeved in series and powered by air hoists. These two floating bases removed as many as eight vessels a day. The method of salvage was simple. A bite would be taken on one of the wreck's timbers to raise one end enough to permit a diver to pass a sling underneath the keel. The same process would be repeated at the other end. Both slings were then secured by a snap ring to a hook, the craft was raised, towed to sea, and dropped. In the case of the heavier junks, the barges worked as a team, each supporting one end of a hulk.

The important part played by rock drills in modern salvage operations was emphasized at Okinawa in connection with a 9000-ton American tanker that had run aground on a submerged reef during a typhoon and was in such a position as to partially block the harbor's narrow entrance. It was decided that, even though the vessel was battered beyond repair, she could be given sufficient buoyancy by patching and pumping to allow two Navy tugs to pull her out of the way by the use of pulleys and beach gear.

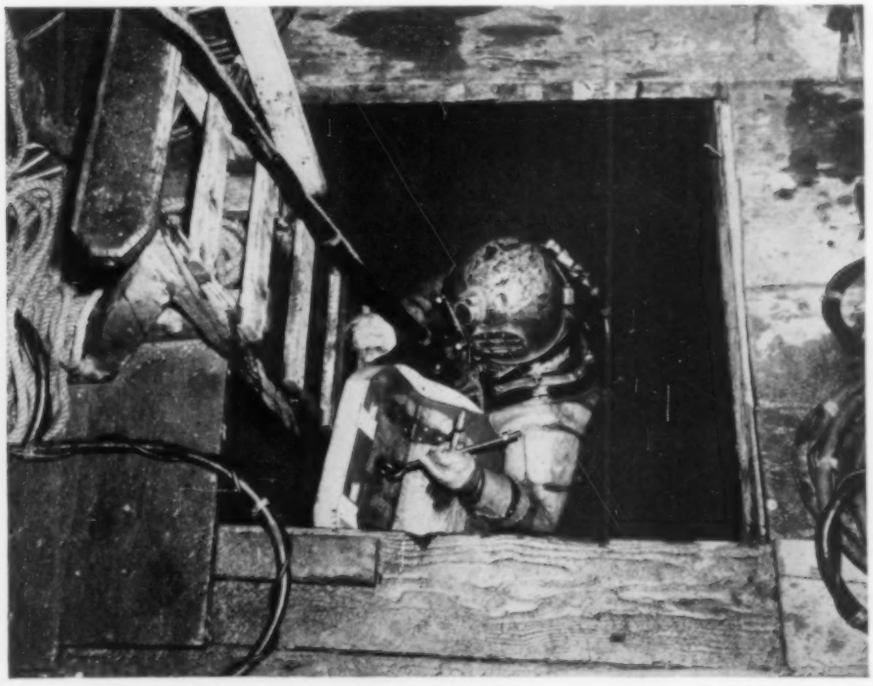
The reef was a slightly sloping ledge of white coral that dropped off sharply to 100 fathoms at about two ship lengths abaft the stern. The forward half of the tanker was in contact with the reef, the impact having crushed the bottom there and caused serious flooding. Prior to grounding, the vessel had a mean draft of 16½ feet, which corresponds to about 9000 tons displacement. After she was stranded, the draft forward was 17½ feet, which is equivalent to a displacement of around 6450 tons and signified that the tanker was grounded by a weight equal to approximately 2650 tons. Repeated attempts were made by the beach gear and tugs to pull her off, but to no avail.

Upon investigation, it was found that a hump of coral, 10 feet high, rested against the ship's port side and held her fast, resisting all efforts of the tugs to free the tanker. The only recourse was to remove the obstruction by drilling and blasting, so a Navy diver was sent down with an Ingersoll-Rand JA55 Jackhamer to do the job. As an underwater-worker's buoyancy is almost equal to that of the water, two 150-pound weights connected by a strap were used to hold the diver-driller in position to operate the Jackhamer at a depth of 4 fathoms.

By reason of the porous nature of the coral, he encountered trouble in removing the drill rods. The Jackbits were then ground down towards the center to provide more clearance and were also sharpened so they could cut themselves out as well as in. So reconditioned, little difficulty was experienced with the detachable bits. As a result, fourteen holes 8 feet deep were drilled in the coral, loaded with 60 percent gelatine dynamite, and detonated with electric caps. The blast loosened the grip of the obstruction enough to permit the tugs and beach gear, combined, to pull the stranded vessel off the reef.

Long before the last of the sunken wrecks was removed from Naha Harbor, American shipping was tying up to stationary docks and unloading cargo with a speed which proved that compressors, pneumatic tools, and pumps perform a vital service in the intricate system of modern warfare.

U. S. Navy Photos

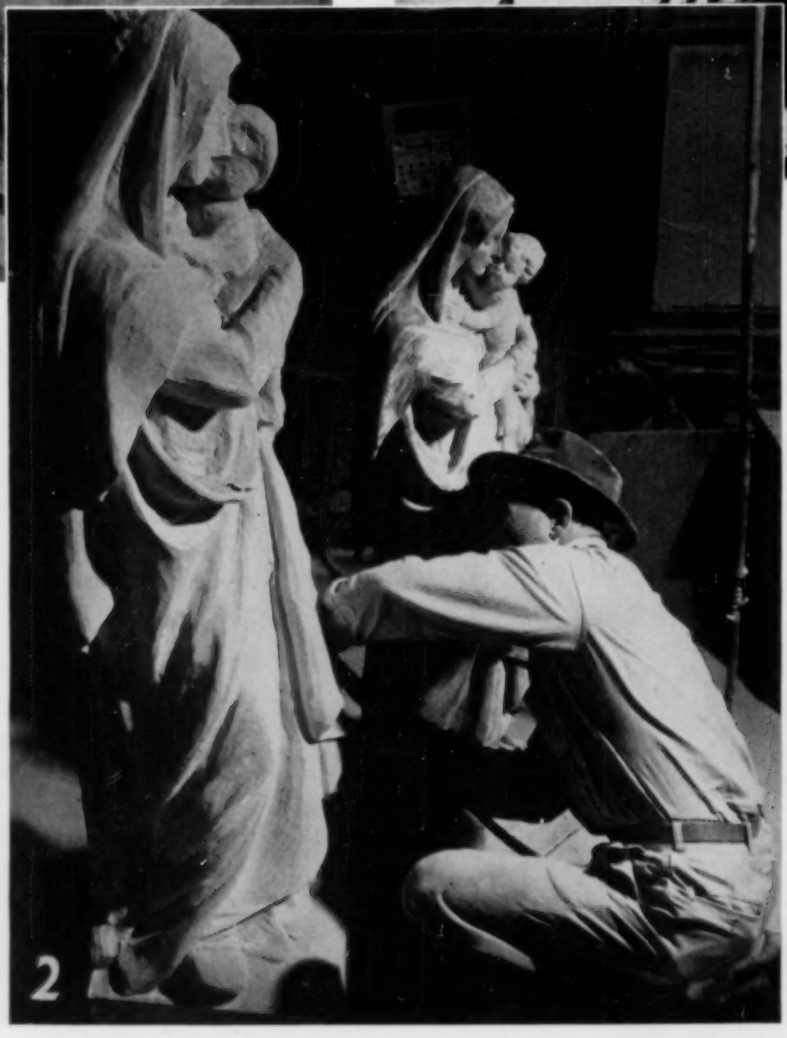


ON THE JOB

Modern communications systems have made the underwater worker's lot easier. The view above shows a deck hand talking with a man on the sea bottom. The diver at the right is descending with a collapsible patch that he will bolt in place over the porthole of a sunken vessel.

From Stone to Statue

Photos from Acme Newspictures, Inc.



THE carving of a stone statue is an exacting task that demands great skill and patience and painstaking work. Even though modern craftsmen have the benefit of tools and methods that were denied the old masters, the fashioning of an image still requires weeks of effort and constant vigilance lest one slip ruin everything done previously.

The traditional mallet and chisel are still used, though sparingly, and principally for the rougher parts of the work. Virtually all of the finishing operations are now done with pneumatic chipping hammers especially designed for the purpose. They strike hundreds of blows per minute, blows the force of which can be regulated so as to do the most delicate sculpturing. The tools are light and small enough to be handled easily and with little physical effort.

These pictures portray the carving of a madonna and child from a block of Indiana limestone by Alex Salvioli of Bayside, N. Y. The first one shows Mr. Salvioli's father, Primo, starting the preliminary work of finishing after the statue

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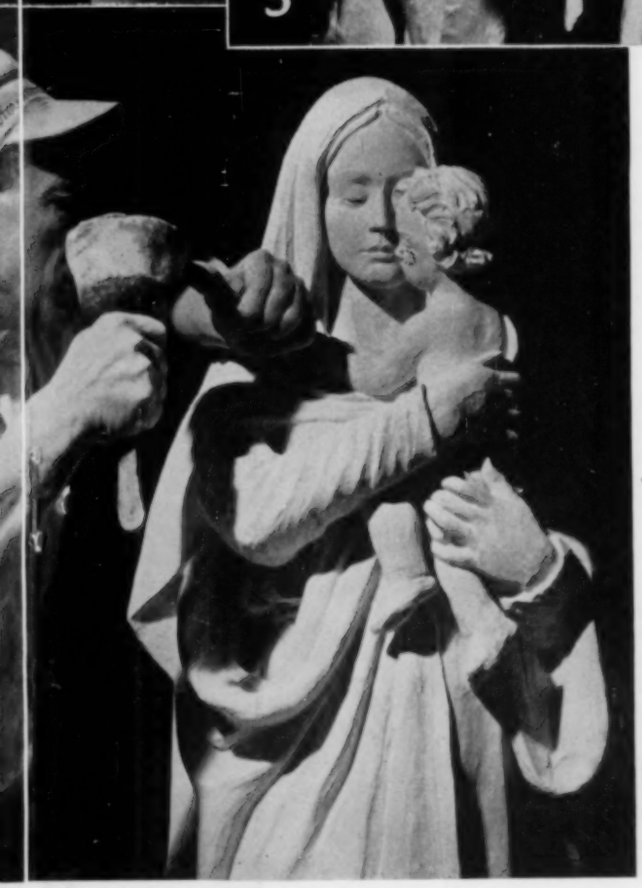

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has been fairly well roughed out of the block. Alongside the latter lies a smaller plaster model of the figures to be duplicated in stone. From this model the guiding dimensions are transferred to corresponding locations on the block with the aid of a pantographic instrument. Surprisingly few points are needed by a trained stoneworker.

In the second illustration, Alex Salvioli is seen working on the folds of the robe of the upright statue, with the model in the background. With the rough carving about completed, the sculptor begins shaping the heads and facial features (No. 3). From this point on, the work must be done carefully and precisely. One chip too many would be irreparable.

The fourth picture shows Salvioli tapping with mallet and chisel to smooth and soften the contours. Final leveling of ridges left by preceding operations is accomplished with a plain-edged air-driven tool (No. 5). The sixth view depicts the completed statue, on which weeks of effort have been expended, mounted in the yard of the Church of St. Philip of Neri in New York City. After it has settled, a rock garden will be planted at its base and Nature will in time add a softening patina to the stone.

SKYLINE REFRIGERATOR

The picture above shows a section of Melbourne's business district. Near the right edge may be seen the water-vapor refrigerating unit atop the main store of Myer Emporium Ltd. Under and left of it is one of the forced-draft fans that serve the cooling tower. Below is a close-up of the refrigerating unit.

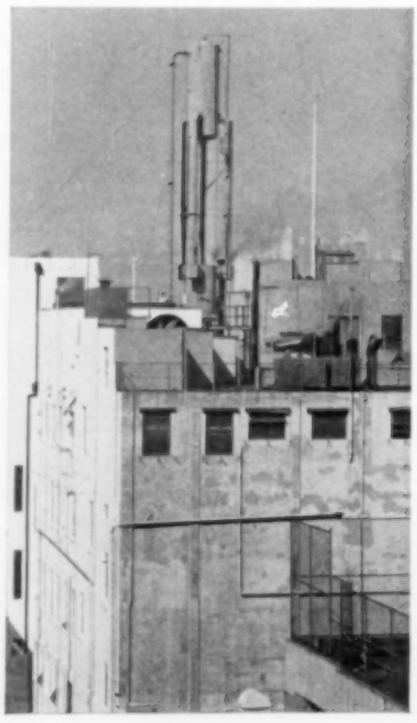
Water-Vapor Refrigeration Cools Australia's Largest Store

MODERN in all respects, the Myer Emporium Ltd., in Melbourne, Australia, is reputed to be the largest department store in the Southern Hemisphere. Like similar establishments in other parts of the world, it is concerned with the comfort of its patrons and employees and, to that end, it conditions the air of the ground floor of its main store on Bourke Street. This is the section that is ordinarily used to display goods that are offered at bargain prices, and it is so expansive that during the pre-Christmas season and at times of special sales there are frequently from 7000 to 8000 shoppers on the floor in addition to approximately 800 salespeople.

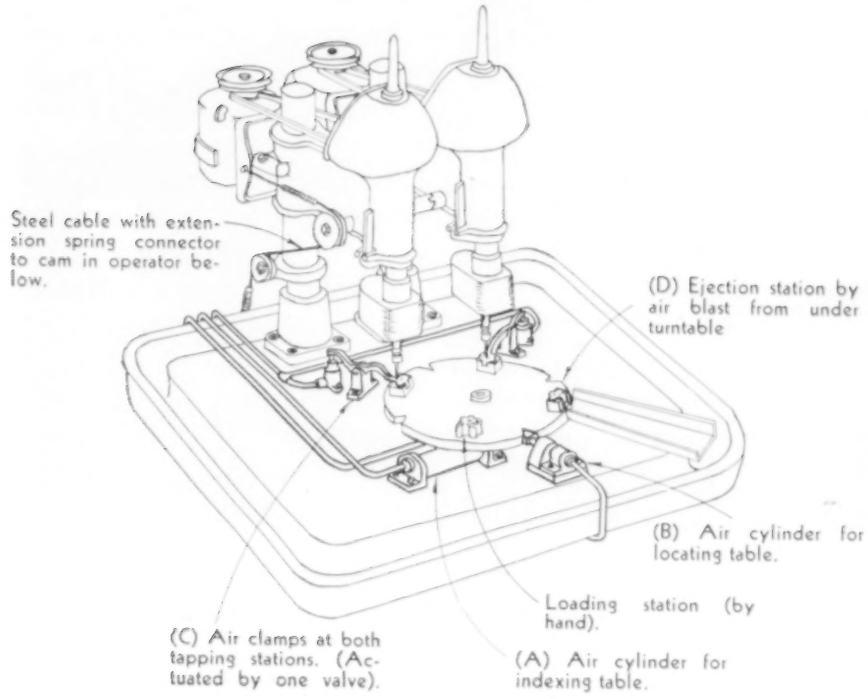
The water that is used to cool the air is chilled in an Ingersoll-Rand water-vapor refrigerating unit. This apparatus, which has been described in detail in earlier articles, produces cold with water unaided by any of the chemical compounds that are associated with most household and commercial systems. The refrigerating effect is obtained by creating a high vacuum in a water reservoir and thereby causing water that is sprayed into it to boil or "flash" into vapor at temperatures below 50°F., as compared with its normal sea-level boiling point of 212°. The heat required to bring about this evaporation is drawn from water that is in the base of the reservoir and that is consequently cooled.

In this instance the refrigerating unit is installed on top of the 6-story Myer building, and the section upon which the load rests was strengthened from the top clear down to the basement. As the barometric condenser in which the steam is reconverted into water rises some 40 feet in the air, it is a novel and somewhat spectacular architectural display that can be seen from most parts of downtown Melbourne. Because of its location, its erection created some problems for W. G. Crossle & Company, the engineering firm that set it up. Fortunately, there was available a builder's jib crane that had been hoisted to the top of the structure to aid in doing some other work. When the refrigerating equipment had been elevated into position there was a space of just 6 inches to spare between the hook of the crane and the top of the condenser.

The unit has a rated capacity of 150 tons of refrigeration when chilling water to 50°F., but it is being operated to produce 128 tons with 45° water. It was installed in 1938 and has been functioning satisfactorily ever since.



Pneumatic Device Operates Standard Machine Tools


Steel cable with extension spring connector to cam in operator below.
(D) Ejection station by air blast from under turntable
(B) Air cylinder for locating table.
Loading station (by hand).
(C) Air clamps at both tapping stations. (Actuated by one valve).
(A) Air cylinder for indexing table.

TYPICAL APPLICATIONS

The schematic drawing shows a set-up for tapping two holes close together in a small metal stamping that is so shaped that it is not practical to feed it by hopper or magazine. An output of more than 800 pieces an hour is attained. The functions of the three air cylinders used are indicated in the drawing. There are many possible variations of this arrangement. An air cylinder often serves to push the work pieces from a magazine or hopper to an air-operated vise or turntable fixture. The picture at the right shows a Pond Operator applied to such a fixture for the production of rubber handballs.

MANY standard machine tools that were formerly hand-controlled have been converted into automatic equipment through the simple addition of a fixture that puts compressed air to work. Many of these hand machines were outmoded, with a trade-in value little higher than their worth as scrap metal. Often their owners were unable to replace them with automatic machinery because of material shortages or prohibitive costs. Hand-operation of millers, drill presses, reamers, tappers, and many other tools kept production down, with consequent high manufacturing costs per unit.

The new fixture, called the Pond Operator, was developed by the Pond Engineering Company of Springfield, Mass., for use in its own plant during the war when the scarcity of manpower was hindering output to an alarming extent. Machines that might have turned out important parts were practically wasted because hand-operation was extremely costly and too slow for the production of essential items. To solve the problem, company engineers devised a control unit to change hand machines over to automatic or semiautomatic operation.

When war demands ceased, Pond began to make the Operator for other establishments that were in much the same situation. Several fundamentally similar models, capable of a variety of functions, were built to meet different requirements. The fixture's most practical application lies in the field of small-parts manufacture—shops and plants where drilling, tapping, milling, slotting, and other similar work take considerable time and labor, which are not always available.

The Pond Operator is usually mounted on a standard base and close to or in conjunction with the machine it controls. A 1/3-hp. electric motor drives the mechanical members of the machine that actuate the pneumatic mechanism. Air power plays an important part in the production cycle because it does the work that was formerly done by hand. The pneumatic components are several small air cylinders. These are connected to the Operator which, in turn, is connected to a compressed-air line. Air at a minimum pressure of 70 pounds is required, but the average consumption is only 1/8 cfm. per unit. Mechanically actuated valves in the Operator control the action of the cylinder pistons causing them to perform essential functions in the cycle. The valves are grouped in an aluminum housing and are actuated by a camshaft that is easily adjusted for cycle speed and for impulse.

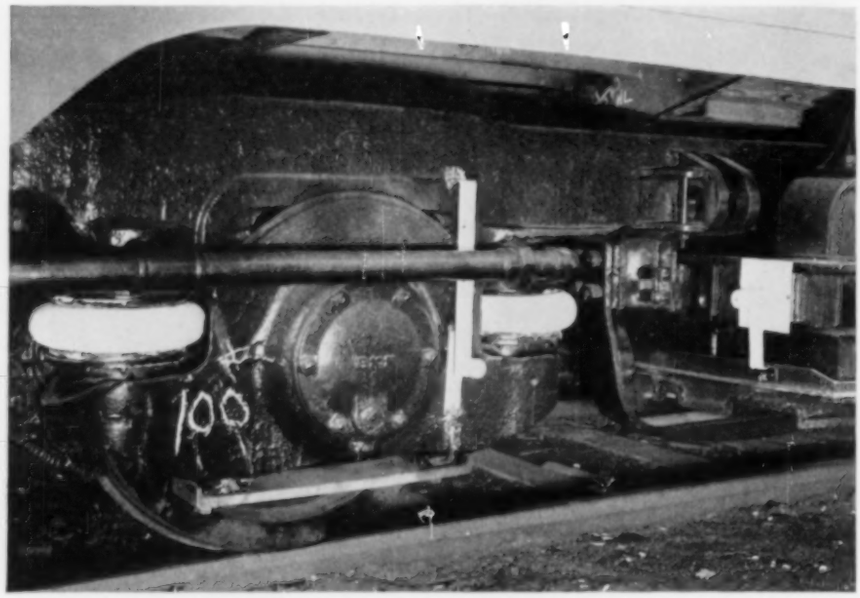
One type of Operator is used exclusively for feeding bar stock into standard production millers, with the air cylinders functioning as follows: One opens and closes a vise and another actuates a sliding stop to position the bar with precision after a mechanical cam has fed the bar, which pushes out the finished piece. A third cylinder pushes the starting lever or button on the miller, and a fourth cylinder engages the clutch on the Operator. The valve for the latter cylinder is controlled by the milling-machine table as it returns to the loading position. Air power accomplishes so many of the functions that formerly required close attention by the human operator that one individual can now attend several machines.

A self-contained fire-fighting car for coal mines has been designed and built by the Dugas Division of the Ansul Chemical Company. The unit carries three 300-pound tanks containing Dugas dry chemical and a 100-gallon water tank, together with four cylinders charged with nitrogen under sufficient pressure to expel the chemical and the water through hose lines having a maximum length of 100 feet. The purpose of the water is to extinguish embers that may remain after the chemical has smothered the flames. Several hand extinguishers and a first-aid kit complete the equipment.

Air Springs Proposed for Railroad Cars

AIR springs that resemble automobile tires laid on their sides are being tested for railroad-car service by their originator, The Firestone Tire & Rubber Company, in conjunction with the Pullman-Standard Car Manufacturing Company. Following three private tests, they were given their first public tryout recently in a special run over the Chicago, South Shore & South Bend tracks between Michigan City and Chicago. On this occasion, one end of a Pullman-Standard laboratory car was equipped with the air springs and the other end with steel-coil springs. Precision instruments capable of checking the slightest variations in lateral sway and vertical motion caused by track irregularities made recordings at speeds ranging from 35 to 80 miles an hour.

The air spring has already been used on airplane landing gear, heavy truck trailers, passenger buses, and Bofors anti-aircraft gun carriers, and has been tested on numerous passenger automobiles. In service, the tirelike bellows is inflated and connected with an air reservoir. When the spring is depressed by reason of a wheel passing over a track irregularity, air is forced from it into the reservoir. The rebound is then snubbed by a control valve between the bellows and the reservoir, thus minimizing the shock to the passengers.



AIR CUSHIONS FOR CAR TRUCKS

The white, tirelike objects on each side of the journal-box suspension are the bellows, each of which is inflated and connected with a compressed-air reservoir. The white square at the right is a scratch plate that records the vertical movement of the car.

Conforming with normal practice as regards steel springs, the truck of the laboratory car is fitted with two sets of air springs. The journal-box springs—two air springs—receive the first impact from the rails. They are at the end of each axle and are 9 inches in diameter and 4 inches high, respectively. Each pair is connected with a common air reservoir. Beneath each end of the truck bolster—the principal lateral member of the truck—is another air spring, 20 inches in diameter and 4 inches high. All are inflated from an outside compressor in the same manner as an automobile tire. The pressure varies anywhere from 75 to 100 pounds, depending upon the load to be carried.

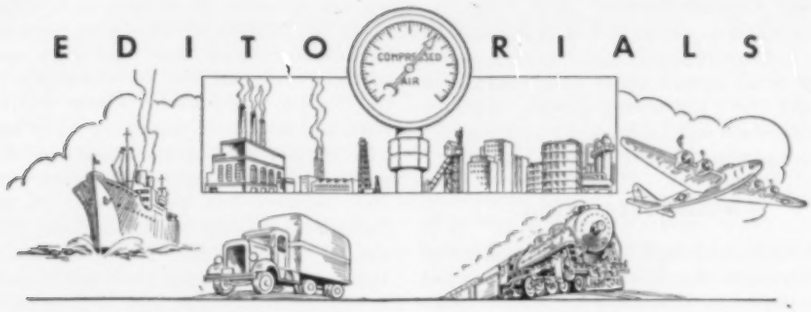
The springs are expected to improve passenger comfort, to outlast the coil spring, and to require less maintenance. In a joint statement, Roy F. Johnson and Roy W. Brown, research engineers for Pullman-Standard and Firestone, respectively, said: "This is the fourth trial run made with air springs under a railway passenger car. The first was made at speeds not higher than 35 miles an hour, to prove out in a preliminary way the safety of the device. The second run was made at speeds up to 55 miles an hour to check on various details of the application, and on the suitability of the recording instruments. The third run was made at speeds as high as 80 miles an hour, and that top was again reached on the fourth run.

"It should be understood that the air spring is still in early stages of experimentation. We are seeking a comparison of its fundamental advantages over the steel coil springs now in ordinary use. This will require many test runs over a period of several months and a variety of adjustments and corrections."

PRIMITIVE METHOD OF BREAKING ROCK

Before explosives were available for blasting, rock was softened or cracked by heating it with fire and then dashing cold water against it to contract it suddenly. The Romans and other early tunnelers and miners used the method extensively. It is now almost but not quite obsolete, as this picture proves. It was taken in Bahia, Brazil, and shows a pile of wood ready for lighting. The rock was being removed to widen a highway curve. The illustration is reproduced by courtesy of the Jaeger Machine Company of Columbus, Ohio.

EDITORIALS



A METAL-MINING PROBLEM

AMERICAN metal mines are suffering from an acute shortage of labor. It is almost as pronounced now as it was during the war, when conditions got so bad that experienced miners were released from the services to return to the production of vitally needed minerals. Some base metals, notably copper, that are essential to getting industry in high gear are in short supply and will likely remain so until more men go back to the mines. The gold-mining properties, which were closed down during the war by Federal action, are having a hard time getting back into production. The Homestake, greatest gold source in the United States, is running at about half normal capacity. The Cripple Creek gold mines in Colorado are still virtually idle, and California gold properties are in much the same category. Canadian gold mines weren't shut down during the war, but their working forces were greatly depleted and they, too, find it impossible to get enough men now.

With national employment at a record high level, competition for workers is keen among all industries, and mining is at a considerable disadvantage largely because of prevailing misconceptions regarding the work involved. Some persons who are familiar with the situation believe the metal-producing concerns would do well to conduct an educational program, or even an advertising campaign, to dispel some of the false notions prospective workers hold about jobs in mines.

Many men who are unfamiliar with mining seem to think it is a dangerous, unhealthful, very laborious, and poorly paid calling. Actually, it is none of these. Its safety record compares well with that of industry as a whole, and greatly exceeds that of many branches. As a matter of fact, there are many surface jobs around mines that are almost devoid of hazards. Modern metal mines take adequate precautions to safeguard their employees against occupational diseases. Moreover, most camps are in mountainous regions blessed with clean, dry air and health-preserving sunshine, and close to natural recreational areas. As for the work itself, most of the back-breaking labor has been removed by the adoption of mechanical aids such as power-feed drills, mucking machines, slusher hoists, etc. The trend towards mechanization is greater now than ever before because the lack of manpower is compelling managements to find ways to increase output per manshift.

Although wages don't equal those that prevailed in war-boomed industries to which many miners gravitated, they will stand comparison with present rates in the heavy industries, especially if it is remembered that rents and some other cost-of-living items are lower in mining communities than in the congested urban centers where most large factories are located. Even unskilled labor is paid at least $8 a day in most of our western mines.

GAS-TURBINE LOCOMOTIVES

WHEN the steam locomotive appeared more than 100 years ago, it revolutionized transportation and was rightfully hailed as a marvelous invention. Compared with the stagecoach, pony express, and other pioneer means of moving goods and people, the railroad signalized the dawn of a bright new era. During the intervening decades, the venerable iron horse has grown greatly in size and power, but not very much in efficiency. The best it can do is to utilize about 8 percent of the power potential of the fuel fed to it.

Rudolf Diesel invented his internal-combustion engine more than 50 years ago, and it has been developed to the point where its efficiency is up to 36 percent, or four and a half times that of the steam locomotive. But the railroads were slow to adopt it, and diesel-powered locomotives were a curiosity in main-line service until the early 1930's. The western railroads took the lead in applying them, and even today the staid and conservative eastern carriers have not made much use of them.

However, the advent of diesel haulage served to spur railroadmen to seek ways to improve the performance of the steam locomotive. Inasmuch as electric generating stations attain efficiencies as high as 30 percent with the steam turbine, considerable work has been done towards developing turbine-driven locomotives, and it has met with enough success to warrant continuing the efforts. In the meanwhile, the gas turbine has sprung into the limelight and opened a new avenue of approach to the locomotive problem.

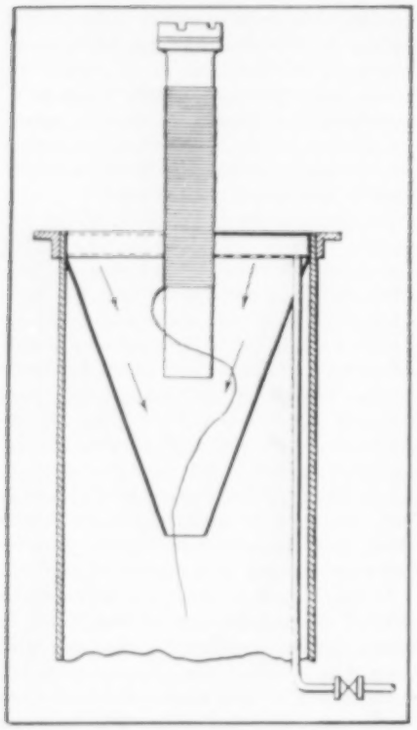
It is desirable that the railroads burn coal, because we have plenty of it and it is less costly than oil. The gas turbine was conceived to burn oil as a matter of facility and convenience, but it was foreseen from the beginning that it might utilize coal if the latter were converted into a form in which it could be instantly ignited and quickly consumed.

Recognizing the possibilities of the gas turbine in their field, a group of railroad executives set about exploring its potentialities as a coal burner, and the coal-mining industry was naturally ready to join in. A million-dollar fund was raised, and John I. Yellott, chief of the Institute of Gas Technology in Chicago, Ill., was assigned the task of developing an experimental coal-fired gas turbine for locomotive service. He went to work at Johns Hopkins University in Baltimore, Md., prepared to spend five years in the effort, but progressed so rapidly that he had one spinning in a matter of months.

In the Yellott contrivance, bituminous coal of the consistency of lampblack is blown into a combustion chamber and burned to produce the propulsive gases. In designing it, two major problems were encountered and overcome. The first one concerned pulverization of the coal and was solved with the aid of compressed air. The coal is first crushed to about the fineness of percolator coffee and is then blown through a nozzle while under high air pressure. When the pressure is suddenly released, air that has been trapped in the pores of the coal particles break them up into powder in a series of miniature explosions. The second stumbling block was that of getting rid of fly ash which would abrade the turbine blades if it was allowed to pass through them. It is removed by Aerotec dust precipitators interposed between the combustion chamber and the turbine.

A locomotive to house the coal-fired gas turbine is now on drawing boards and is expected to be on rails in about two years. It will be a curious iron horse, for it will use no water and have no boiler and, consequently, will be only half as long as a diesel locomotive of equivalent power. A contract has been let to Allis Chalmers Manufacturing Company for a 3750-hp. gas turbine that will drive an electric generator to supply energy to propulsion motors. The unit will embody an axial-flow compressor that will compress air, which will be heated to 1300°F. before entering the turbine. Engineers estimate that the turbine will have a shaft efficiency of around 24 percent. The over-all efficiency of the locomotive will therefore greatly exceed that of the conventional steam model, although it will not equal that of the diesel type. But as coal to run it will cost only about a third as much per heat unit as diesel oil, the prospects of lower operating costs are bright.

Bobbin Waste Removed by Compressed Air



AIR DOES THE STRIPPING

With a bobbin held top down in the cone, compressed air is admitted to remove the roving waste and to carry it to a bin in the picker room. Around the exhauster is built a short table, about 18 inches wide, to hold the bobbins to be stripped.

ROVING-BOBBIN waste is no longer removed manually in one textile mill. Instead of sending bobbins with two or more rounds of roving on them to the stripping machine, where the waste is pulled off by hand or cut off with a knife, they now go to what the plant calls a bobbin-waste exhauster. The latter is a simple contrivance in which blasts of air do the work much faster than the older method and also without risk of damage to bobbins and injury to operators.

The device both strips the bobbins and delivers the roving to a bin in the picker room. It is nothing more than an upended metal tube, 8 inches in diameter, in the top of which is an inverted cone forming an angle of about 20° with the side of the cylinder and open top and bottom to receive a bobbin and to exhaust the waste, respectively. Around the upper end of the tube is a copper pipe that is connected by a length of piping, extending downward through the cylinder, with a compressed-air line.

Perforations on the inner periphery of the ring permit the air to enter the cone, and as it flows downward it unwinds the bobbin and carries the roving along with it through the exhauster tube and a horizontal metal pipe attached to the lower end of it. Additional air is admitted at the L-shaped bend in the latter; but, in the case of an exceptionally long conduit, or where there are several elbows, more air connections will be needed to convey the waste to the bin in the picker room.

Synthetic Mica

SOME time back we made mention of the fact that Germany has developed a satisfactory substitute for mica. Since then the Office of Technical Services, U. S. Department of Commerce, has published a report (PB-32545) by Paul M. Tyler on the product, the research work involved, and the pilot-plant operations by Siemens-Schuckert and the Kaiser Wilhelm Institute.

According to Mr. Tyler, the Siemens-Schuckert mica is made by melting tablets containing aluminum oxide, magnesium oxide, sand, and potassium silicofluoride, properly proportioned, in a specially designed covered crucible. When charged, the latter is preheated to about 1652°F. in an electrical-resistance furnace and then moved to a gas oven where the temperature is raised to approximately 2610°. Next, as the molten mass is cooled very slowly the mica sheets begin to form upward from the base of the crucible, where a piece of sintered alumina has been placed. Perfect sheets, of as much as 62 square inches, were thus produced in a 45-pound crucible before air raids and a lack of supplies terminated the work. The Kaiser Wilhelm Institute used similar methods to manufacture mica, but, in addition, tried to orient the crystals by means of a magnetic field surrounding the crucible in a horizontal plane.

Dr. V. Middel, an expert at Siemens-Schuckert, stated that the man-made material was utilized in Germany for heavy-duty condensers where natural mica had failed. In discussing its properties (Report PB-32546) he said that it is purer and more uniform than the latter and therefore has higher electrical and breakdown resistance. Its melting point also is higher, about 2340° as against 1080°, and it is harder than Indian muscovite. In his opinion, because it does not discharge gases under a high vacuum, the synthetic mica should make it possible to develop completely noiseless radio tubes.

Safe Magnesium Storage

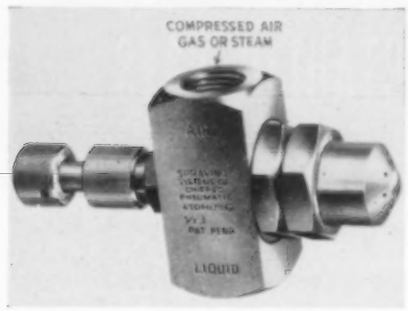
STORING magnesium in separate piles with spaces in between and the use of standard automatic sprinkler systems are the best protection against fires from that source. This is one of the findings of the Factory Mutual Laboratories following large-scale tests inside a building to determine the burning characteristics of that metal. Even though the water intensifies the flames and hastens the destruction of the magnesium, the general room temperature under sprinkler discharge is lower than it would be without it and the fire is more apt to be confined to one pile. It was found that 600 pounds of burning castings, even when a considerable distance from walls and partitions, would completely destroy a plank-on-timber structure not equipped with automatic sprinklers. On the other hand, a similar pile of magnesium castings, protected by such a system, would not set afire other piles but 4 feet distant.

HE KEPT IT MOVING

The Metropolitan Water District of Southern California moved this 4-room house 100 miles from Eagle Mountain Camp to Gene Camp to provide a home for a doctor. In some places there was a clearance of only 6 inches between the walls of rock cuts. The truck driver had instructions not to stop, lest some family move into the structure before it reached its destination. The photograph is reproduced through the courtesy of the "Colorado River Aqueduct News."

Industrial Notes

Spraying Systems Company is offering a new large-capacity atomizing nozzle of the internal-mixing type for ½-inch pipe connections. Built to operate with compressed air, other gases or steam can be



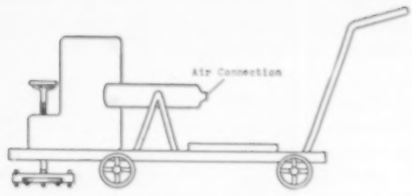
used. The one illustrated is provided with a shut-off needle but may be obtained in each size without that feature. Nozzles are made of brass or stainless steel and have a capacity range of 20, 40, and 60 gallons an hour.

Sam Tours & Company, Inc., engineers, metallurgists, and consultants with laboratories at 44 Trinity Place, New York 6, N. Y., is offering industry a service of so-called nondestructive field testing for corrosion, erosion, liquid level, and dezincification of piping and equipment. According to the firm, two new instruments —the Penetron and the Probolog—make it possible for its trained engineers to examine high-pressure pipe lines from the outside for dangerous internal corrosion or erosion, to explore ships' hulls and tanks for thinning of walls which may lead to serious loss, and to test heat exchanger and condenser tubes for detrimental conditions.

Pioneers in the use of X-ray apparatus to detect flaws in the welds of pressure vessels, Babcock & Wilcox has broken ground at its Barberton, Ohio, plant for a structure to house a 2,000,000-volt unit. The company now has twelve X-ray machines in service there. The largest is a 1,000,000-volt unit that takes radiographs of steel walls 6 to 7 inches thick. The new equipment is designed to operate at any voltage from one to two million, and will take pictures of heavy welds from 4 up to 10 inches in thickness. The building in which it will be set up will have 42-inch walls of sand packed between ¼-inch steel plates to protect persons in the immediate vicinity from radiation.

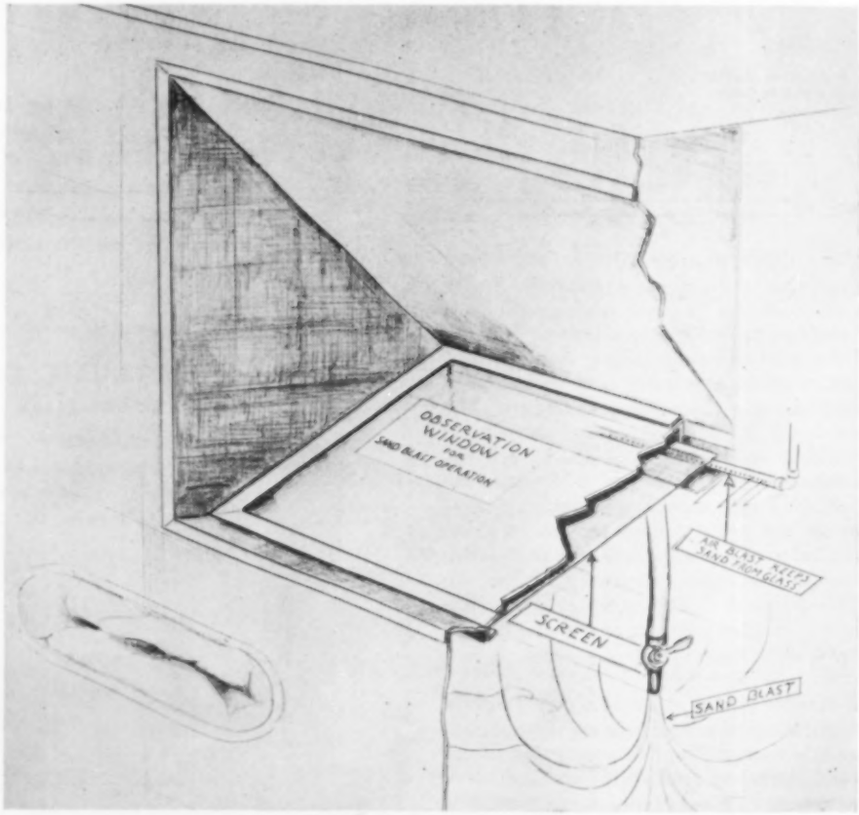
At the plant of the Florence Stove Company, a General-Electric gauge is being utilized to determine the thickness of white enamel covering stove parts. This results in the same degree of whiteness throughout after a stove has been assembled and is saving $600 a month in rejects. If the thickness varies more than 0.0015 inch anywhere, a difference in whiteness will be discernible. Parts were formerly matched visually for color after the enamel had been baked on them. This meant that any that did not come up to standard had to be scrapped, as the enamel could not be removed. Now the gauge determines the thickness of the film that is required to give the desired color, and a pressure control on an automatic sprayer is then set to deliver precisely that thickness. If an error is made at that stage, the enamel can be washed off and the part resprayed.

Among the pneumatic equipment contrived during the war for plant maintenance is a portable, rotary scraper for reconditioning concrete floors. The machine is designed to remove encrusted and embedded dirt, oil, and metal chips, as well as to smooth down surface irregularities. It was built of boiler plate and equipped with a cutter head provided with four standard Carboloy tools or blades tipped with cemented carbide. The latter project slightly beyond four carbide blanks set in a steel guide ring that



is a part of the head and that controls the depth of the cut necessary to get down to clean concrete. An air motor serves to drive the scraper, and up or down movement is effected by a hand-operated screw wheel. The truck carrying the equipment can be pushed along by one man but is heavy enough to keep the cutting head in contact with the floor when in action. Primarily a shop idea, there is probably a field of application for a power scraper of this kind.

For metallurgical laboratories, where surfaces are intermittently exposed to hot and cold water, steam, and many chemical solutions, the use of Vulcabond, a new protective coating, is recommended. It is a thermosetting compound made by the Bray Corporation, which claims that it re-



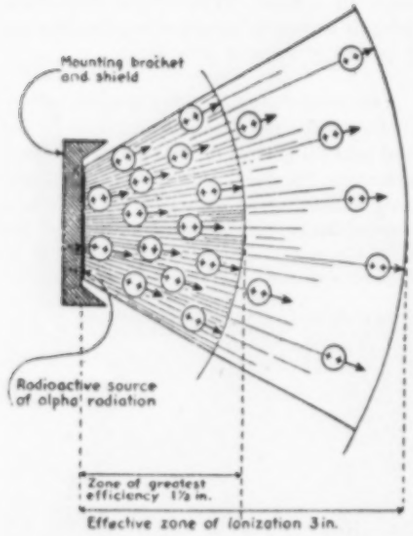
AIR CURTAIN PROTECTS SANDBLAST OBSERVATION WINDOW

By blowing a curtain of air across the underside of a window over sandblasting apparatus, engineers at the Bloomfield, N.J., Lamp Division of the Westinghouse Electric Corporation prevent the glass from being pitted by flying sand and have reduced replacements by as much as 90 percent. A ¼-inch perforated pipe is mounted as shown, and compressed air is admitted from the plant line that supplies the sandblast.

mains hard, smooth, and clean, as well as impervious to the many destructive agents that attack paint. It is applied by spray gun, brush, or dipping and is suitable for wood, metal, glass, and fabric.

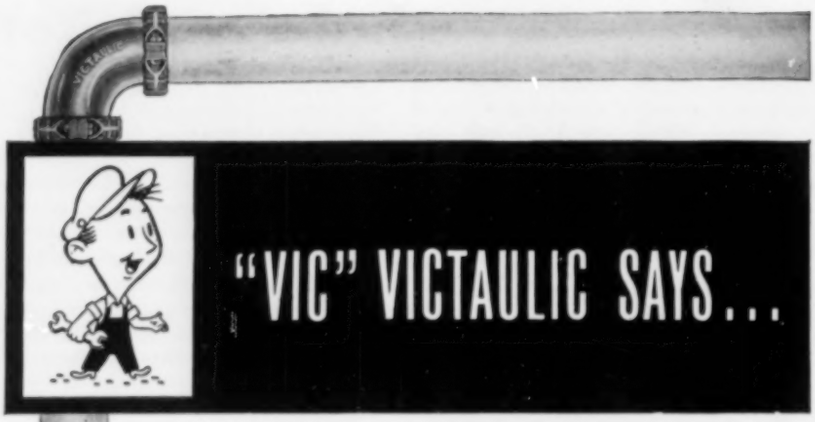
Static electricity, which tends to form between moving sheets of paper, plastics, fabrics, and other materials, has long been a production headache because it causes the sheets to stick together, to stack unevenly, and even to result in faulty ejection from machinery. Different methods have been tried to overcome the difficulty, such as passing sheets over open gas flames or spraying solutions on them, but hitherto none has fully satisfied the requirements of all materials.

Approaching the problem from an entirely different angle, the United States Radium Company has developed a device that is said to meet the diversified needs. It ionizes the air within a zone of 3 inches from a static neutralizing element consisting of an extremely thin metallic foil embodying a radioactive substance. The foil is welded to a nonradioactive metallic backing and serves as a seal to prevent the escape of radon gas. The entire assembly forms a long, narrow strip that sends out a continuous stream of alpha radiation of constant strength that counteracts the static electricity within the zone affected. The Ionotron Static Eliminator can be made in any shape service conditions may dictate.


Mounting bracket and shield
Radioactive source of alpha radiation
Zone of greatest efficiency 1½ in.
Effective zone of ionization 3 in.

Grafize is the name of a new graphite lubricating powder made by the Schmidgall Manufacturing Company for motor cars, workshop appliances, and industrial equipment. Finer than face powder, it is put up for ease of application in bellows-type cartons and is said to withstand extremely high and low temperatures.

According to the South African press, a large deposit of chrysotile asbestos that is said to compare favorably with the Ca-



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"...and Victaulic Couplings do. They allow for expansion and contraction caused by temperature changes. They automatically relieve pipeline stresses.

"Special expansion joints aren't necessary in a Victaulic line... because the Victaulic Coupling floats in the pipe end grooves. There is clearance on either side of the housing and yet a leak-tight, positive, slip-proof lock at every joint!

"And this same feature offers a *flexible* coupling... allowing your pipeline to follow the contour and curves with a minimum of fittings—eliminates the need for accurate alignment.

"For an economical, efficient and dependable piping system, use Victaulic Couplings and Victaulic Full-Flow Fittings."

Write for new Victaulic Catalog and Engineering Manual

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Victaulic Company of Canada, Ltd., 200 Bay St., Toronto
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Have you considered Victaulic for your piping requirements?
Sizes—¾" through 60"

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VICTAULIC
EFFICIENT FULL-FLOW FITTINGS

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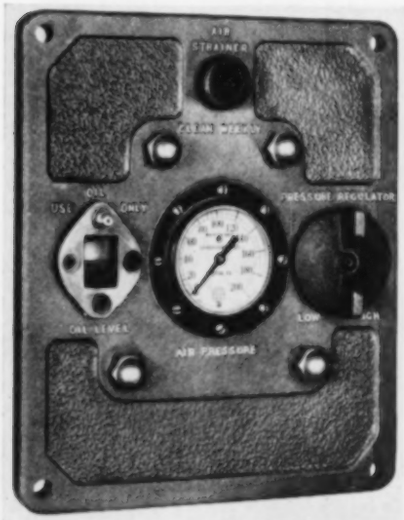
nadian fiber has been located at Carolina. Engineers have reported that the ore bodies occur in lodes and veins over a strike of 4 miles from east to west in the center of three parallel mountain ranges in the area. A company is being organized to exploit them.

Buckeye Laboratories Corporation has developed a storage tank for dehydrated lubricating, insulating, or other oil in which it is kept dry under a vacuum of 5 microns. The unit is used in combination with equipment made by the company for the removal of water, gases, and volatile acids from such oils.

The Pennsylvania Coal Company announces that loud speakers will be placed throughout the underground workings of its Ewen Colliery at Pittston, Pa., to broadcast music to some 1000 miners. If the experiment has the desired effect—reducing fatigue and improving morale—similar facilities will be provided in the company's other mines.

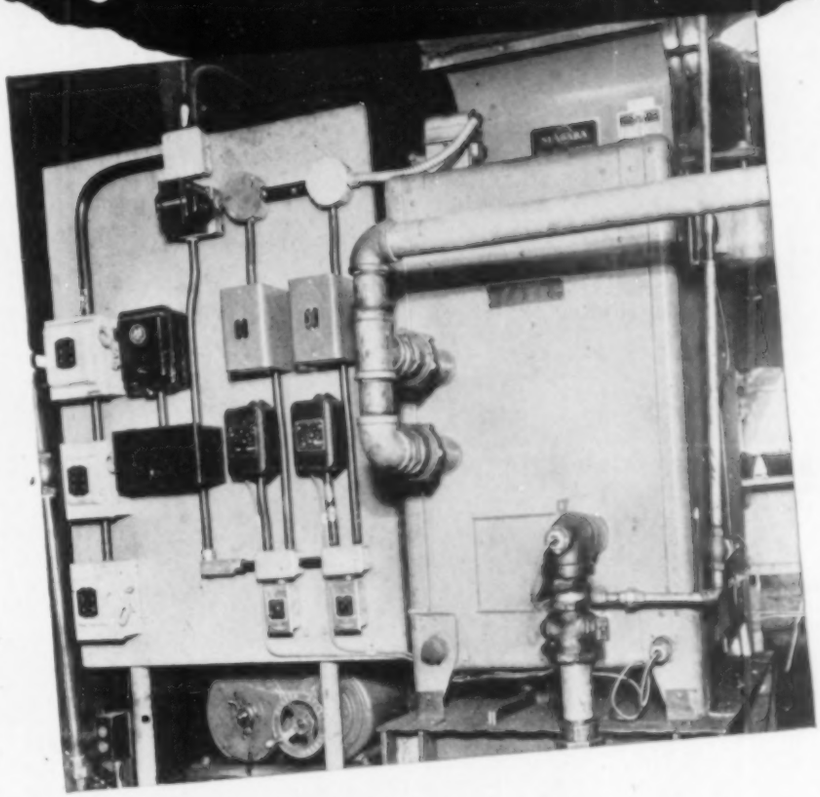
Initial heating from a cold start in 90 seconds is one claim made for a new electric soldering iron. It has a built-in thermostat to control the temperature and is provided with six interchangeable tips. One is of the cup type for dip operations such as are required in wiring. Device is named Kwikheat and is made by the Sound Equipment Corporation of California.



AIR-CONTROL PANEL

This air-control assembly, including an air valve, air strainer, air gauge, pressure regulator, and lubricator, is mounted on a panel $8\frac{1}{16}$ by $9\frac{1}{2}$ inches in size and is designed for insertion in a cavity in a machine tool at the time the latter is built. It will accommodate $\frac{3}{8}$- or $\frac{1}{2}$-inch air piping, also arranged in the cavity. The entire mechanism is at the rear of the panel and can easily be removed for maintenance or repair. Called the Lehigh-Marton Panel Unit, it is made by Lehigh Foundries, Inc., Easton, Pa.

LET *Air* DO THE WORK OF COOLING



• The NIAGARA AERO HEAT EXCHANGER makes the atmospheric air take up the heat you want to remove from power equipment or industrial process. It is done by the evaporation of a small amount of water, removing 1000 BTU for every pound of water evaporated. With this method it is also easy to control temperatures closely . . . to assure accuracy in process results . . . speeding up production at lower cost.

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Industrial Literature

Pure-white fire hose that has been treated to make it water repellent and resistant to mildew is described in Bulletin AD-8002 issued by American-LaFrance-Foamite Corporation, Elmira, N.Y. The hose is built to withstand abrasion and temperature extremes from freezing to blistering heat.

National Electric Products Corporation, Chamber of Commerce Building, Pittsburgh, Pa., has issued a booklet, No. 466, describing its Gorilla-Grip electrical connectors. The publication was compiled to give engineers, jobbers, contractors, and industrial purchasing agents an understanding of the design and function of these units.

An illustrated bulletin on protected-type standard squirrel-cage induction motors is offered by the Louis Allis Company, Milwaukee 7, Wis. Typical applications are the driving of blowers, refrigeration compressors, close-coupled hydraulic pumps, multistage pumps, and machine tools.

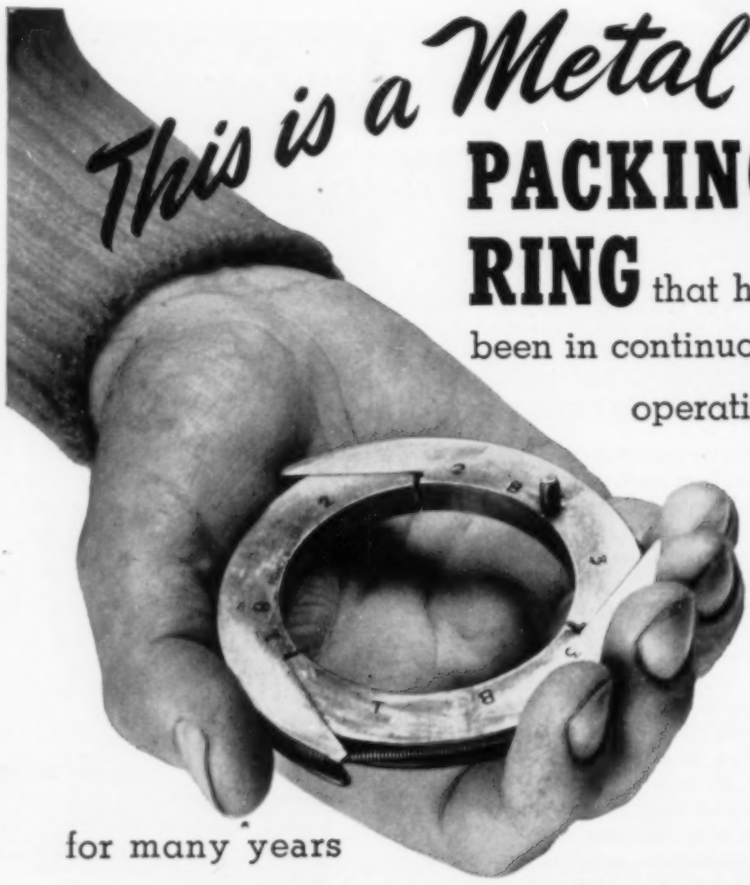
An 8-page folder issued by the George Scherr Company, 200 Lafayette Street, New York 12, N.Y., describes Scherr micrometers, which were formerly sold under the name of Reed. All Scherr micrometers are now provided with a ten-thousandth-inch vernier, if desired. The booklet lists various toolmakers' and machinists' specialties.

The function of a packing in a hydraulic or pneumatic machine is to prevent the passage of fluid between stationary or moving parts. The medium against which the packing must operate and the pressure that is exerted against it will obviously determine the type of packing required. There are four standard types of leather packings, each suitable for meeting certain conditions. A complete discussion of them, including engineering data, is contained in a new *Hydraulic and Pneumatic Leather Packing Guide* that is available from Alexander Brothers, 406 North Third Street, Philadelphia 23, Pa.

The cold-working of metal surfaces by shot peening to increase their endurance in service was practiced to a considerable extent during the war and is therefore of interest to metal-working plants. A description of all phases of the process is contained in a new booklet, *Shot Peening*, issued by the Pangborn Corporation of Hagerstown, Md., after two years of preparation. The shot can be impelled by either rotoblast or airblast equipment.

Complete "package substations" that incorporate in one ready-to-assemble unit the hundreds of components that have previously been obtainable piece by piece for installation by the customer have been announced by General Electric Company, Schenectady 5, N.Y. They are available in various arrangements in ratings up to 45,000 kva. A descriptive 78-page bulletin, GEA-4500, contains 30 illustrations of typical arrangements of these substations.

The principles of pictorial engineering drafting, as used in isometric and dimetric projection, are explained in a 20-page illustrated booklet written by Paul F. Boehm and distributed by John R. Cassell Company, Inc., 110 West 42nd Street, New York 18, N. Y. Information is given about the use of Instrumaster stencils, which have been developed to speed up the making of isometric and dimetric drawings. The title of the booklet is *Axonometric Drawing—the Universal Picture Language.*



This is a Metal PACKING RING that has been in continuous operation for many years in a high speed Ammonia Compressor.

This is a Man using the time he used to spend replacing soft packing.

REPRESENTATIVES IN PRINCIPAL CITIES

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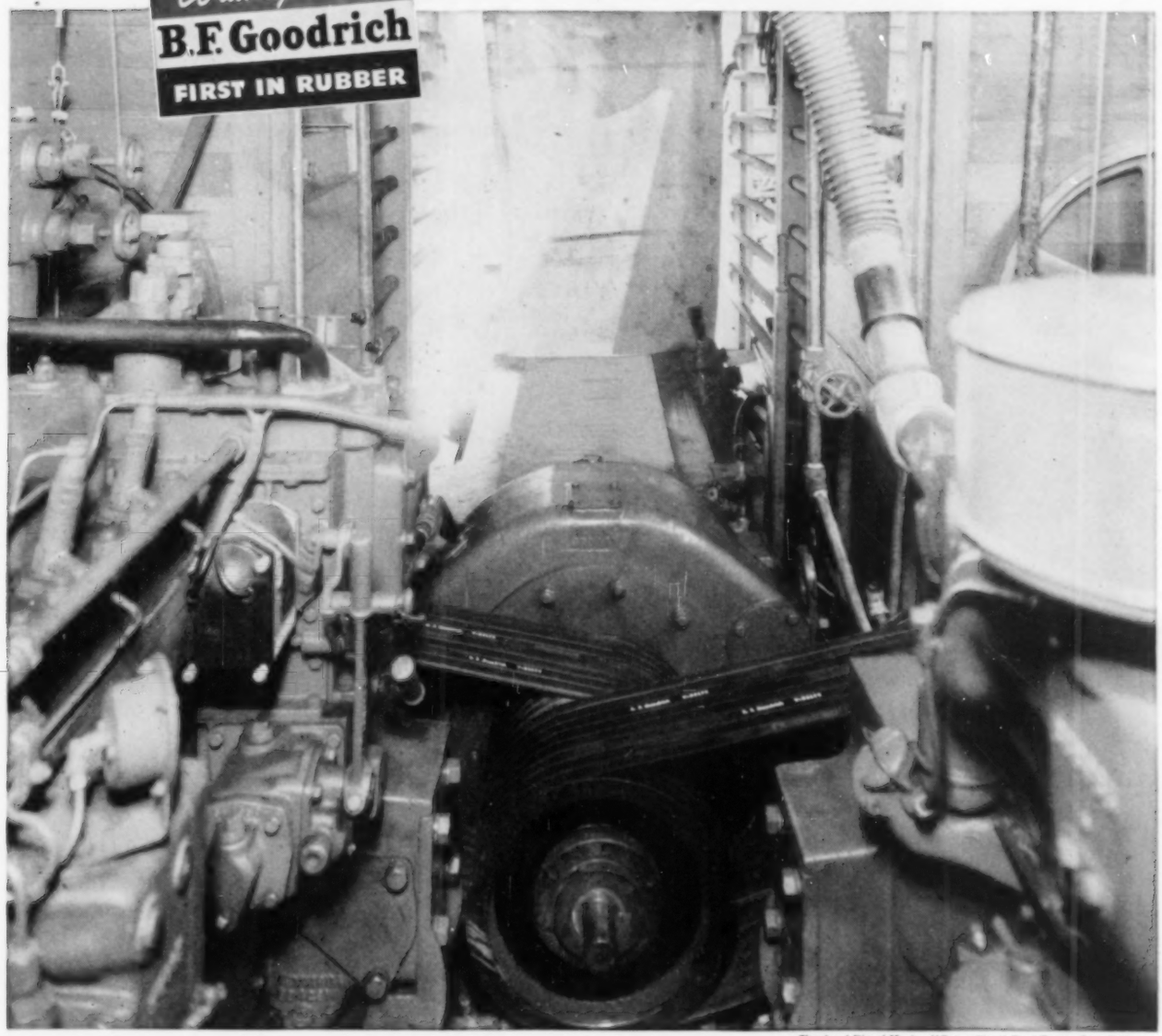
FIRST IN RUBBER



Shepherd Diesel Marine "Caterpillar" Dual Design Installation

Quiet! Fishermen at work

A typical example of B. F. Goodrich development in rubber

YOU'RE way under water in that picture—those are the engines below the water line in a new commercial fishing boat. Most engines turn the propeller through chain or gear drives. But they cost a lot to maintain; breakdowns waste time and are dangerous. And the noise from these drives scares away the fish.

B. F. Goodrich had long been recommending, for use in industry, Multi-V belt drives—a number of carefully matched rubber-and-cord belts that are quiet and vibration-free; that are clean and require no maintenance. Why wouldn't a drive like this be good for fishing boats?

Shepherd Diesel Marine installed one in a new boat—and found the answer. They *are* good for fishing boats. They last longer, cost less to operate, weigh less—and they make the boat so quiet that the "take" of fish is greater—the crew can catch a boat load, get to shore, and be back at work again hours and sometimes days sooner.

B. F. Goodrich first developed the V belts to drive the fan of your car; now these belts also drive boats, and equipment of almost every kind in thousands of plants and on thousands of farms. This sort of development work is going on always at B. F. Goodrich. It is applied to the improvement of everything made of rubber, and that is why you're sure of the latest improvements when you specify B. F. Goodrich to your distributor. *The B. F. Goodrich Company, Industrial Products Division, Akron, Ohio.*

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RUBBER *and* SYNTHETIC *products*

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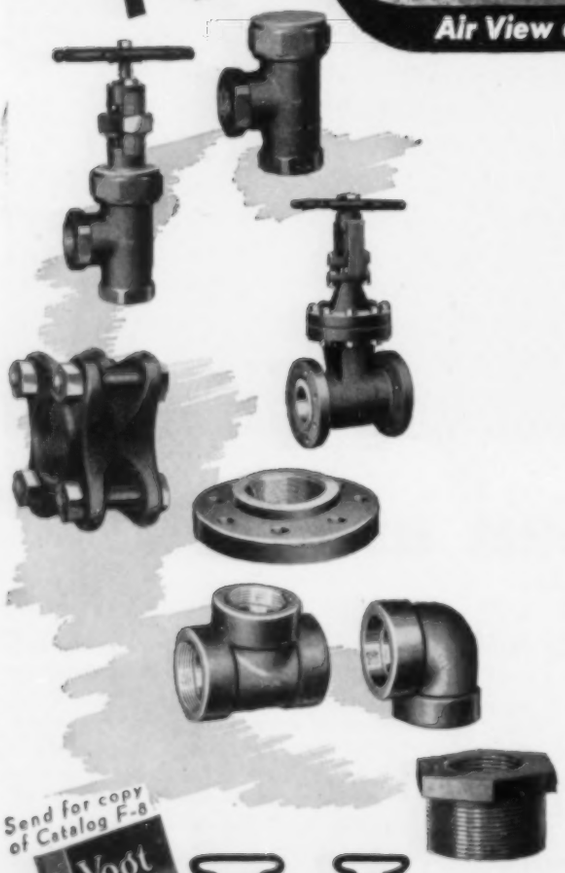
WRITE!

WIRE!

PHONE!

Air View of Henry Vogt Machine Co. Plant, Louisville, Ky.



VOGT provides one convenient, economical source of supply with the most comprehensive line of drop forged steel piping materials anywhere available to industry. Here will be found everything needed for the safe and efficient control of oil, steam, water, air, gas, and ammonia at high or low pressures and temperatures.

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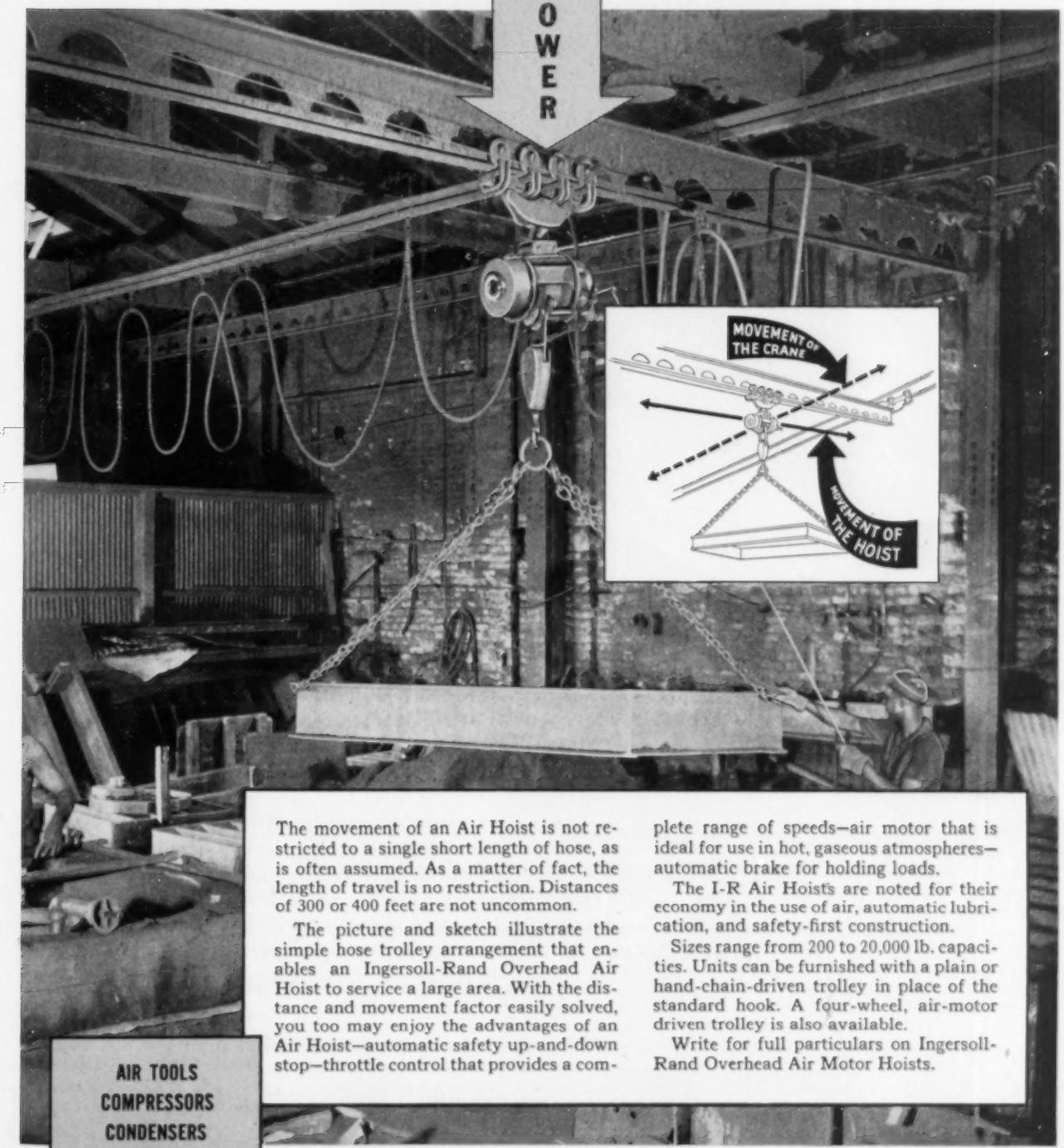
DROP FORGED STEEL VALVES, FITTINGS AND FLANGES

Don't overlook the MOVE of an Air Hoist..

LIFT

LOWER



The movement of an Air Hoist is not restricted to a single short length of hose, as is often assumed. As a matter of fact, the length of travel is no restriction. Distances of 300 or 400 feet are not uncommon.

The picture and sketch illustrate the simple hose trolley arrangement that enables an Ingersoll-Rand Overhead Air Hoist to service a large area. With the distance and movement factor easily solved, you too may enjoy the advantages of an Air Hoist—automatic safety up-and-down stop—throttle control that provides a complete range of speeds—air motor that is ideal for use in hot, gaseous atmospheres—automatic brake for holding loads.

The I-R Air Hoists are noted for their economy in the use of air, automatic lubrication, and safety-first construction.

Sizes range from 200 to 20,000 lb. capacities. Units can be furnished with a plain or hand-chain-driven trolley in place of the standard hook. A four-wheel, air-motor driven trolley is also available.

Write for full particulars on Ingersoll-Rand Overhead Air Motor Hoists.

AIR TOOLS
COMPRESSORS
CONDENSERS
ROCK DRILLS
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OIL & GAS ENGINES

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DOES PULSATION PLAY TRICKS IN YOUR PLANT?

HOW TO CUT H.P. LOSSES

Pulsative flow in gas, air and vapor lines doesn't limit its effects to visible or audible vibration in plant buildings and equipment, or to inaccurate orifice meter readings. It also wastes power because compressors must overcome the reflection of the pulsation cycle in addition to keeping the gas stream moving forward.

For example—Tests conducted recently by a Natural Gas Company showed a horsepower loss of 10.3% on the crank end and a loss of 12.4% on the head end of its compressors. After installing FLUOR Pulsation Dampeners on discharge lines, *this power loss was reduced 76% on the crank end and 53% on the head end.* By eliminating pulsative flow and its adverse characteristics, the FLUOR Pulsation Dampener quickly pays for itself through the saving it effects in power cost. Only 24 hours were required to make this installation.

The FLUOR Pulsation Dampener has no moving parts. It operates with beneficial effects on friction losses, horsepower savings and rate of flow. If vibration plays *tricks* in *your* plant, it may be due to pulsative flow in air, gas or vapor lines. In that case, the FLUOR Pulsation Dampener is your answer.

BE SURE WITH FLUOR SINCE 1890

FLUOR PULSATION DAMPENER

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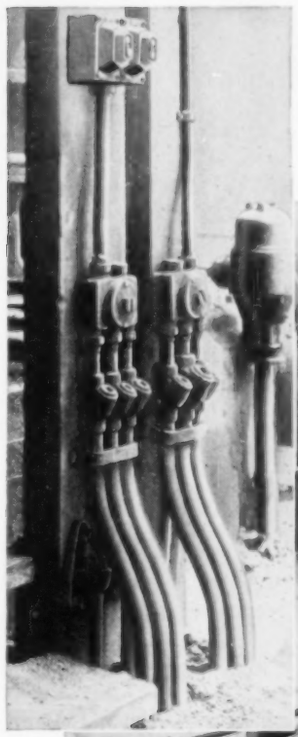
ENGINEERS • MANUFACTURERS • CONSTRUCTORS

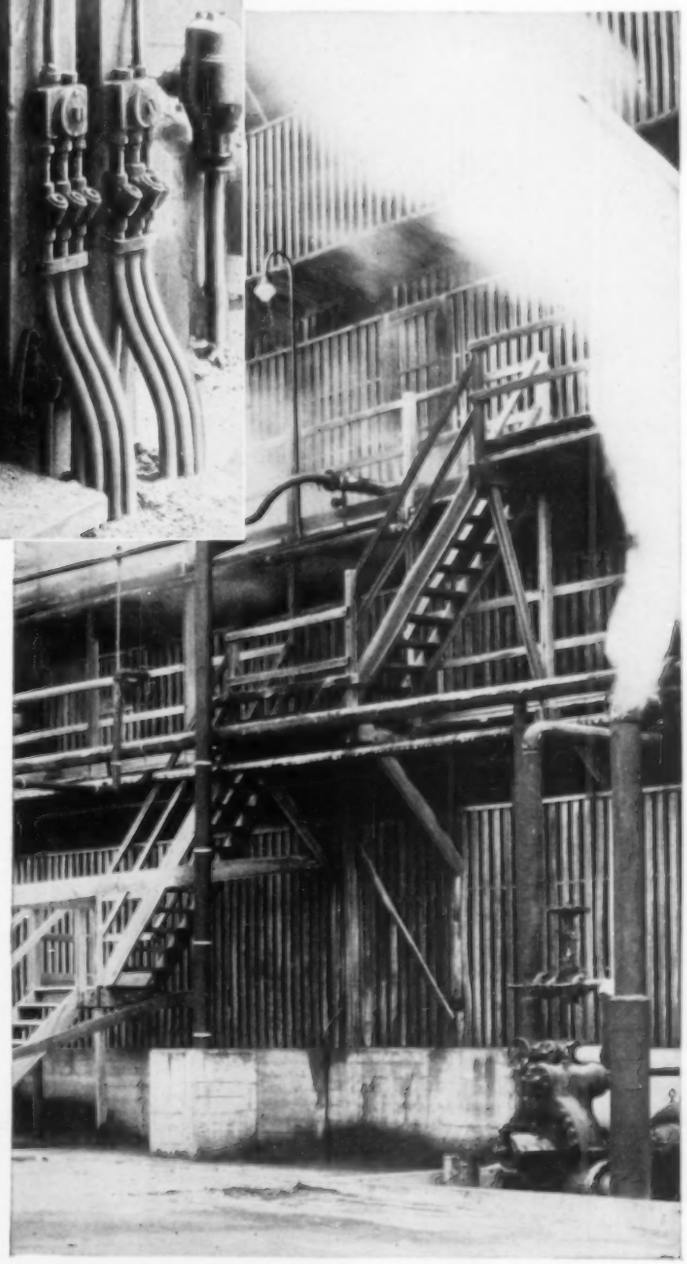
Where Rustable Conduit Fails in months

Everdur lasts for years...



This concentration of Everdur Electrical Conduit and Everdur fittings at left is located in a moist alcove between cooling towers, yet shows no evidence of corrosive attack.

Everdur Electrical Conduit installation at the Torrance Refinery of General Petroleum Corporation after 8 years service in corrosive atmosphere.



A GOOD EXAMPLE of the ability of Everdur* Copper-Silicon Alloy to withstand severe corrosion is this conduit installation of the Torrance Refinery of General Petroleum Corporation.

Because corrosion-resistant materials were not available, several installations of ordinary conduit were made during the past five years. In the vicinity of the cooling towers, the action of spray from chemically treated water is so severely corrosive that one such installation was replaced twice in two years.

How does Everdur Electrical Conduit stand up under such conditions? This durable material installed eight years ago shows *no effects other than discoloration.* Accordingly, General Petroleum now has definite plans for replacing corroded conduit with Everdur. 46194

*Reg. U. S. Pat. Off.

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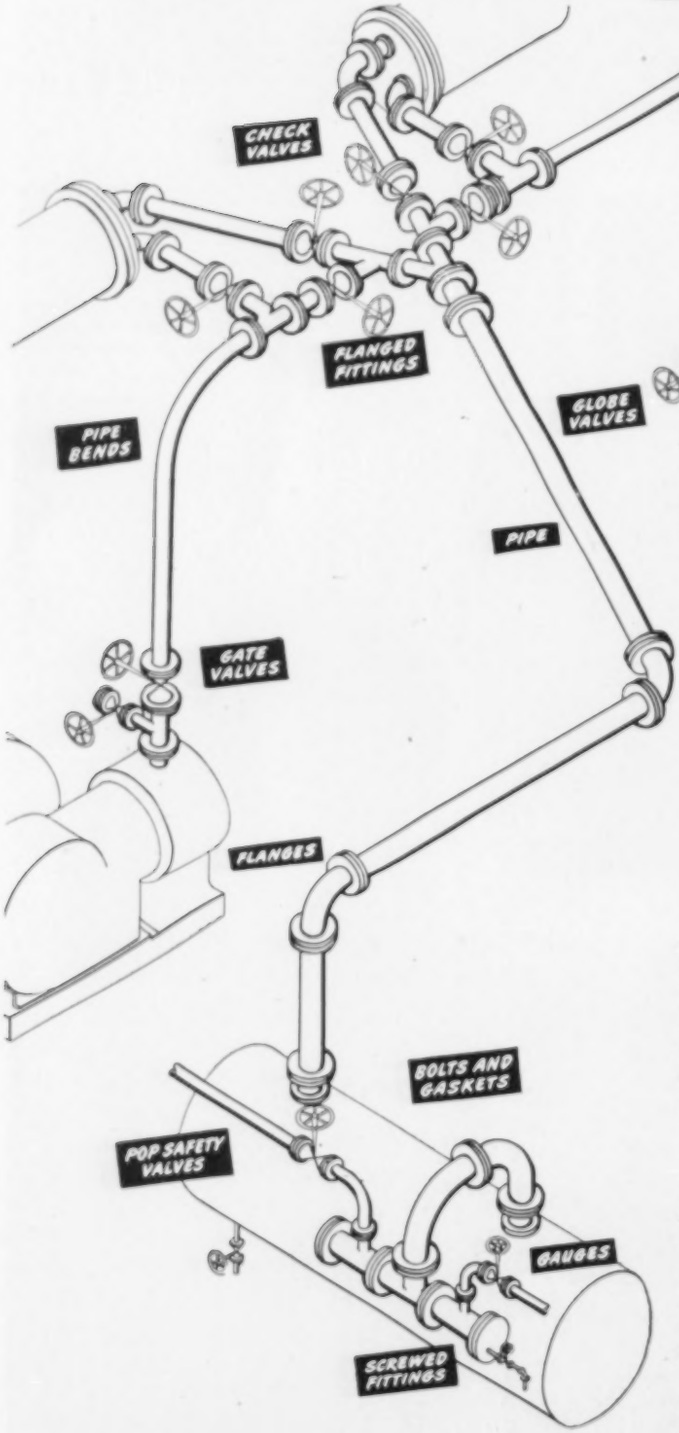

ONE
SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

It's well worth remembering and using now—the service that simplifies all your piping jobs from plan to installation. And the one that assures uniform dependability in every part of piping systems.

For example, on this compressor installation, look what it means to have the Crane line for your partner:

—All valves and fittings, pipe, accessories, and fabricated piping units are specified from a single source.
—One order to your Crane Branch or Wholesaler gets them all.
—Undivided responsibility for materials speeds the job. Crane quality throughout guards against untimely breakdowns of piping, and excessive upkeep.

In brass, iron, and steel equipment, Crane gives you the world's most complete selection. There's no limit on your taking advantage of this Crane service. Think it over—now! CRANE CO., General Offices: 836 S. Michigan Ave., Chicago 5, Ill.
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(*Right*) **GREATER ADAPTABILITY** *for more services—Crane Standard Iron Body Wedge Gate Valves. Improved body design reduces weight yet increases strength. Straight-through ports assure streamlined flow. All parts developed to give dependable, durable service. For steam pressures up to 125 pounds; 200 pounds cold. Patterns for every need. See Crane Catalog, page 101.*

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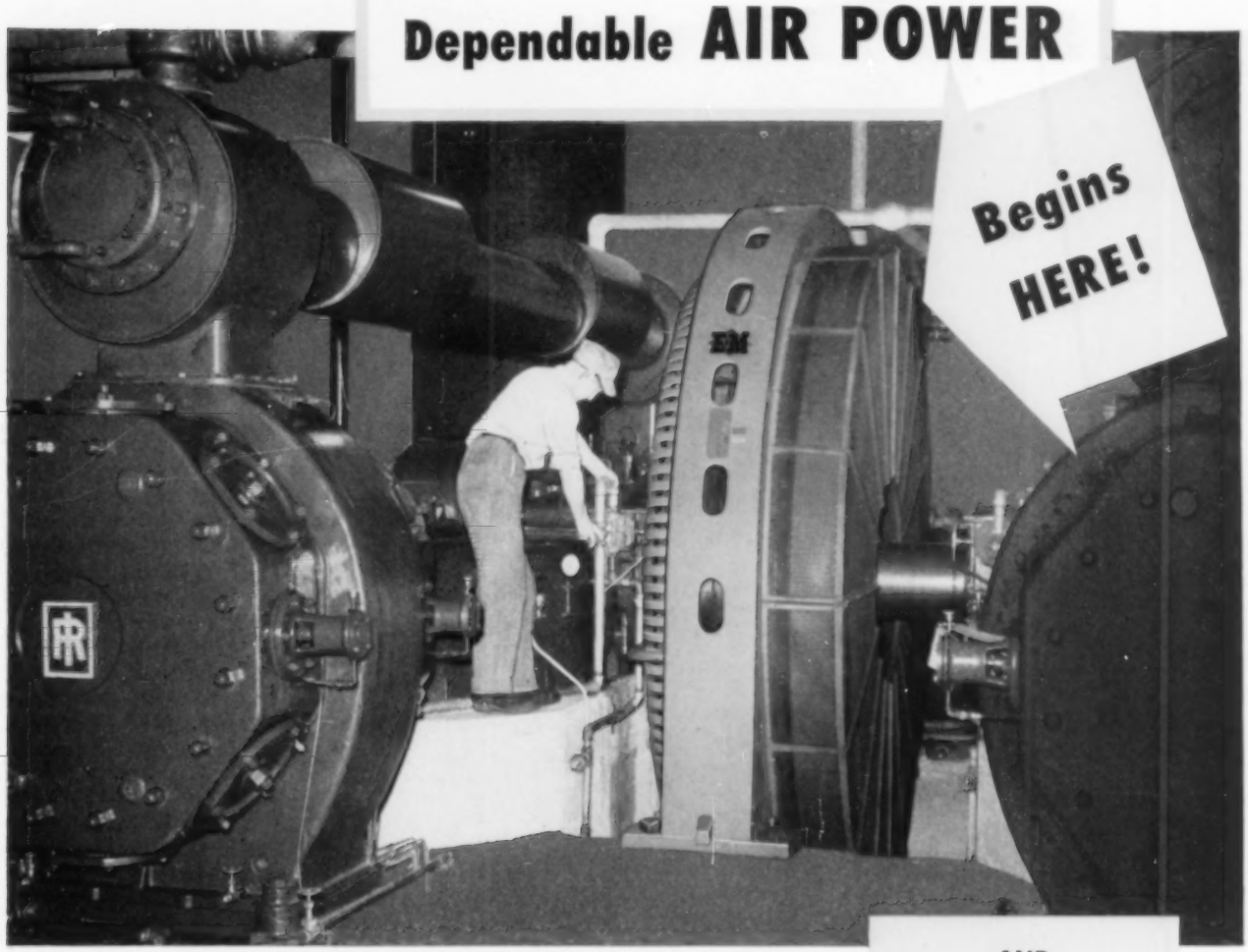
CRANE

FOR EVERY PIPING SYSTEM

Dependable AIR POWER Begins HERE!



AND

CONTROL

IS AS IMPORTANT AS THE MOTOR

● Direct-connected, engine-type synchronous motors and big reciprocating compressors are natural work partners. Today, synchronous motors are the standard drive for such compressors.

A simple, compact drive, the rotor is mounted directly on the compressor crankshaft. The motor fits neatly into compressor design in a straightforward, inherently reliable solution of drive requirements. Ease of preventive maintenance insures trouble-free performance—users don't worry about synchronous motors.

Synchronous motors cut down operating costs of compressors, too. They convert electrical power to drive power with higher efficiency than any other motor and permit preferential power rates through power factor correction.

Let synchronous motors work for you! Using these motors on your compressors means greatest dependability and lowest power cost. Large compressors like the one pictured here are built around motors such as this one, rated 1000 hp, 180 rpm.

The specialized job of E-M engineers in field and factory is to apply and install better synchronous motor drives for your compressors. Contact the E-M field engineer for more information about synchronous motors.

E-M Polarized Field Frequency Control cooperates with the synchronous motor to provide smooth, powerful, trouble-free starting and to insure continuous production. You get "conscious control" with E-M's *polarized* synchronizing.

ELECTRIC MACHINERY MANUFACTURING CO.

MINNEAPOLIS 13, MINNESOTA

E-M

THE SYMBOL OF BETTER ENGINEERING AND MANUFACTURING

A-2040

● *Built by* AMERICAN HOIST & DERRICK CO.

move MORE with SKF-equipped cranes

Modern machines need bearings that can keep today's pace with production's high-speed requirements. Take this rugged, well-designed American Locomotive Crane, for instance. It's perfectly obvious that, with SKF Bearings to keep parts moving smoothly, this crane enables one man and a helper to accomplish the work of many men in much less time. The presence of SKF Bearings is *your* warranty of rolling alignment and maximum load carrying capacity combined with infrequent lubrication requirements, low maintenance costs, and many other advantages. Dispose of *your* bearing problems by referring them to SKF . . . today.

6109

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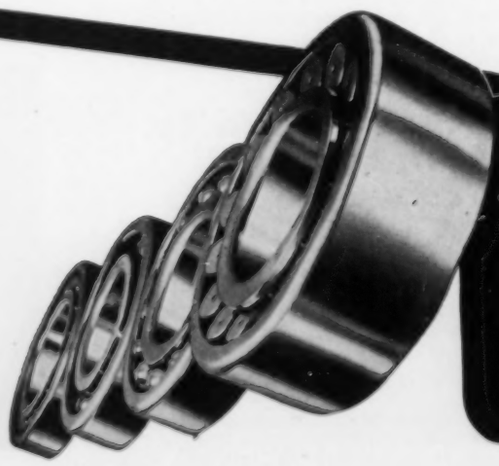


SKF
Puts the
RIGHT BEARING
in the
RIGHT PLACE

A-O Safety Goggles Safeguard the Eyes of Industry

NEW

A-O RUBBER FRAME GOGGLES

Provide Maximum Protection Against Chemical and Dust Hazards . . .

The new A-O Rubber Frame Goggle has a single large acetate lens, which provides exceptional wide-angle vision. Frame is molded from non-irritating, acid-resisting synthetic rubber, which will stand up under long, hard wear. It is scientifically designed to conform to face contours, providing an acid- and dust-tight fit. Cushioned and ventilated for maximum comfort. Especially recommended for maintenance men on acid lines and storage batteries; for workers on metal plating baths, foundry shake-out, railroad car and coal handling apparatus cleaning, and in ship holds and engine cabs where dust is a dangerous factor. Send for bulletin which fully describes the various outstanding features of this new A-O development.

American Optical COMPANY *Safety Division*

SOUTHBRIDGE, MASSACHUSETTS
BRANCHES IN PRINCIPAL INDUSTRIAL CITIES

IT COULD BE ANYWHERE IN THE U. S. A.

THIS familiar sight of a contractor's crew breaking up old pavement with air hammers preparatory to repaving — viewed here by youthful cyclists with much interest — calls for thousands of I-R *Mobil-Air* Compressors in continuous service every day.

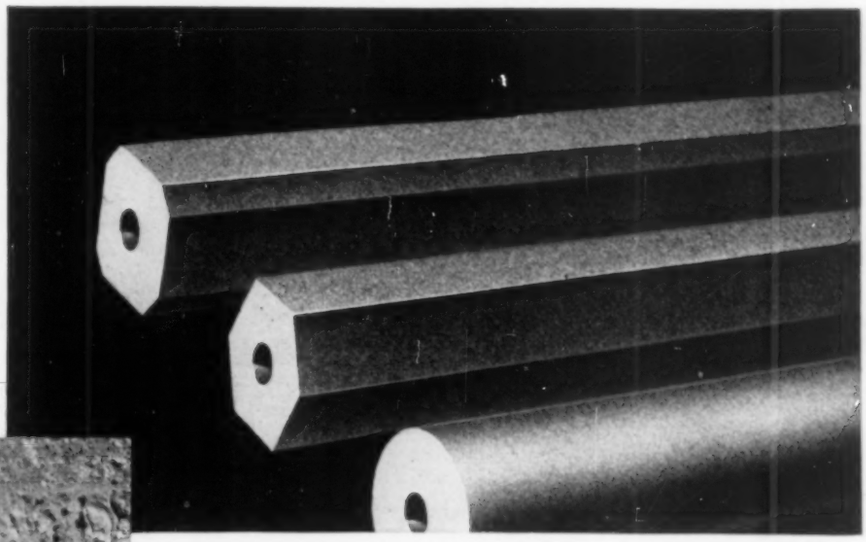
I-R *Mobil-Air* Compressors are equipped for easy starting under all conditions and trouble-free operation with *Flex-Disc* Clutches.

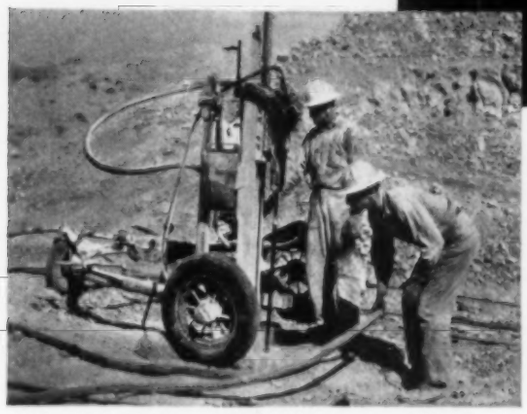
Flex-Disc Clutches are designed so that worn friction facings may be quickly detached in segments, relined, or replaced without disconnecting engine from compressor. Maintenance is reduced and simplified to the highest degree.

INDUSTRIAL CLUTCH CORPORATION

Waukesha Wisconsin

FORGE YOUR BITS?





OR USE DETACHABLES?

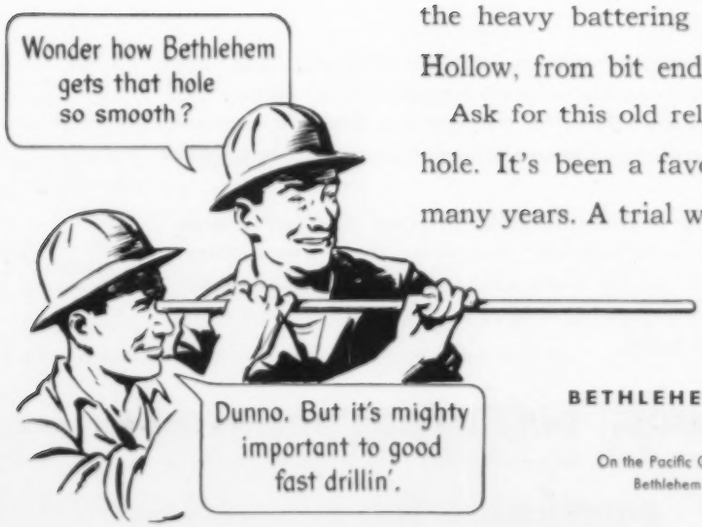
Either way, you're safe with Bethlehem Hollow Drill Steel.

It gives you a keen, sharp edge, with plenty of hardness on the cutting surface, when you forge your own bits.

But if your preference runs to detachable bits, you'll like the easy threading of Bethlehem Hollow. It makes up into a beautiful rod with a neat, tight fit.

And in either event, you'll find that the shank stands up to the heavy battering of the piston. Every inch of Bethlehem Hollow, from bit end to shank, is tough and fatigue-resistant.

Ask for this old reliable steel with the smooth, well-centered hole. It's been a favorite on mining and contracting jobs for many years. A trial will show you why.



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On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

BETHLEHEM STEEL

★ BETHLEHEM HOLLOW DRILL STEEL ★

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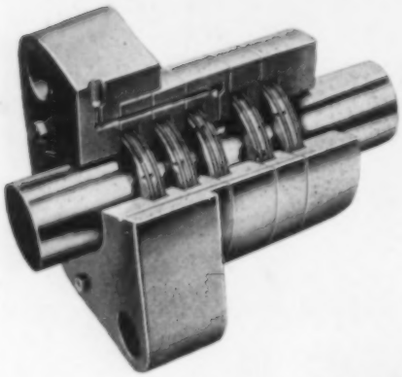
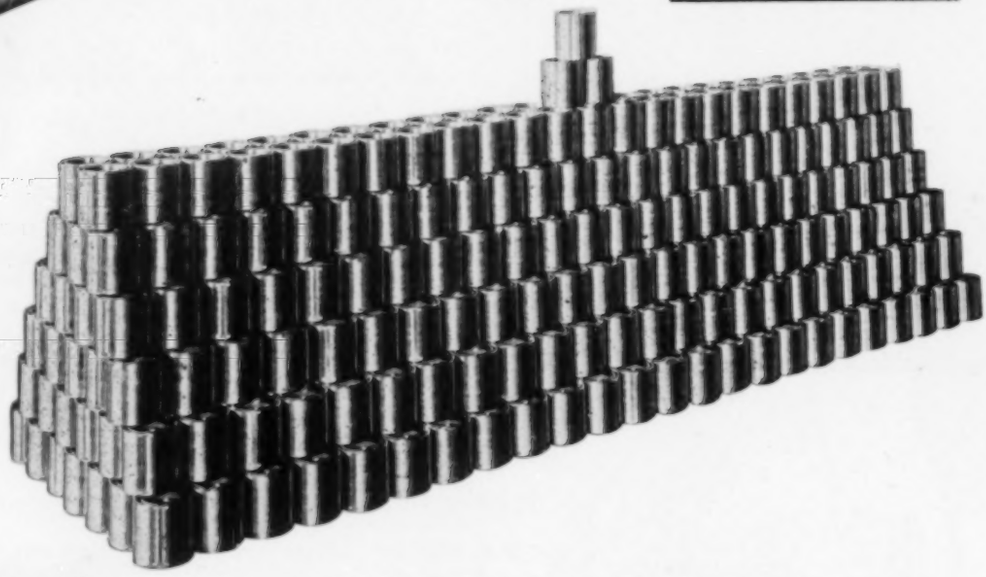


ONE SET OF PACKING...

OR A THOUSAND



COOK IS READY TO SERVE YOU

Whether your requirements are small or large, Cook is always ready to serve you.

And here at Cook there is one standard of service, and only one—the best that a capable, efficient organization can render. So, whether you need a single set of packing or a thousand, you can count on the same prompt and painstaking attention for which Cook is noted.

We can prove this to your satisfaction if you will send us your order the next time you need packings. Remember, there is an approved style of Cook packing for every make of engine and compressor. A copy of the Cook Packing Catalog No. 440 will be sent on request. Write for it today.

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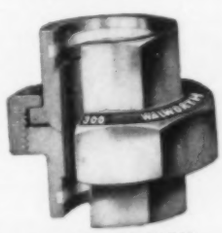
Leakproof SILBRAZ* *joints*

IN COPPER OR BRASS PIPE

with WALSEAL* fittings, flanges, valves

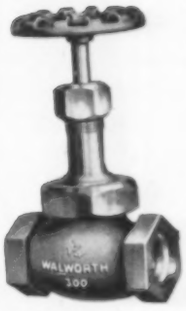


WALSEAL UNION

WALSEAL 90° ELBOW

WALSEAL Y BRANCH

WALSEAL TEE



WALSEAL GLOBE VALVE

WALSEAL CROSS

WALSEAL OPEN RETURN BEND

WALSEAL COUPLING

WALSEAL FLANGE

This illustration shows only a few of the many Walseal valves, fittings, and flanges made by Walworth.

Silbraz joints are the strongest joints that can be made on brass or copper pipe or tubing They cannot creep or pull apart under any temperature or pressure which the pipe or tubing itself can safely withstand.

Silbraz joints are easily made with an oxyacetylene torch. When alterations to the line are necessary, Silbraz joints can be taken apart by reheating with the torch The Walseal valves or fittings used for making Silbraz joints may be re-used in the same or a new position. Enough alloy usually remains in the insert groove of the valve or fitting to permit a second Silbraz joint to be made, without the necessity of inserting additional alloy.

Walseal valves, fittings, and flanges for making Silbraz joints are a modern development of the Walworth Company — manufacturers of valves and pipe fittings for more than a century. For detailed information about Walseal products, write for Circular 84. For information on Walworth's complete line of valves, fittings, and pipe wrenches write on your company letterhead for a free copy of Catalog 42.

* Registered trade marks

One-Piece PIPE LINES

The above illustrates the details of a Walseal tee and Silbraz joints. The center port has been cut away to show the ring of silver brazing alloy which is inserted by the manufacturer in the ports of every Walseal product

The right-hand port has been cut away to show the penetration of the alloy after the pipe and fitting have been silver brazed.

The left side of the tee shows the fillet of silver brazing alloy which completely encircles the pipe at the juncture of pipe and fitting — indicating that the Silbraz joint is completed. Because the brazing alloy penetrates both pipe and fitting, the resulting Silbraz joint actually makes the pipe and fitting into a one-piece pipe line.

WALWORTH

valves and fittings

60 East 42d Street, New York 17, N. Y.

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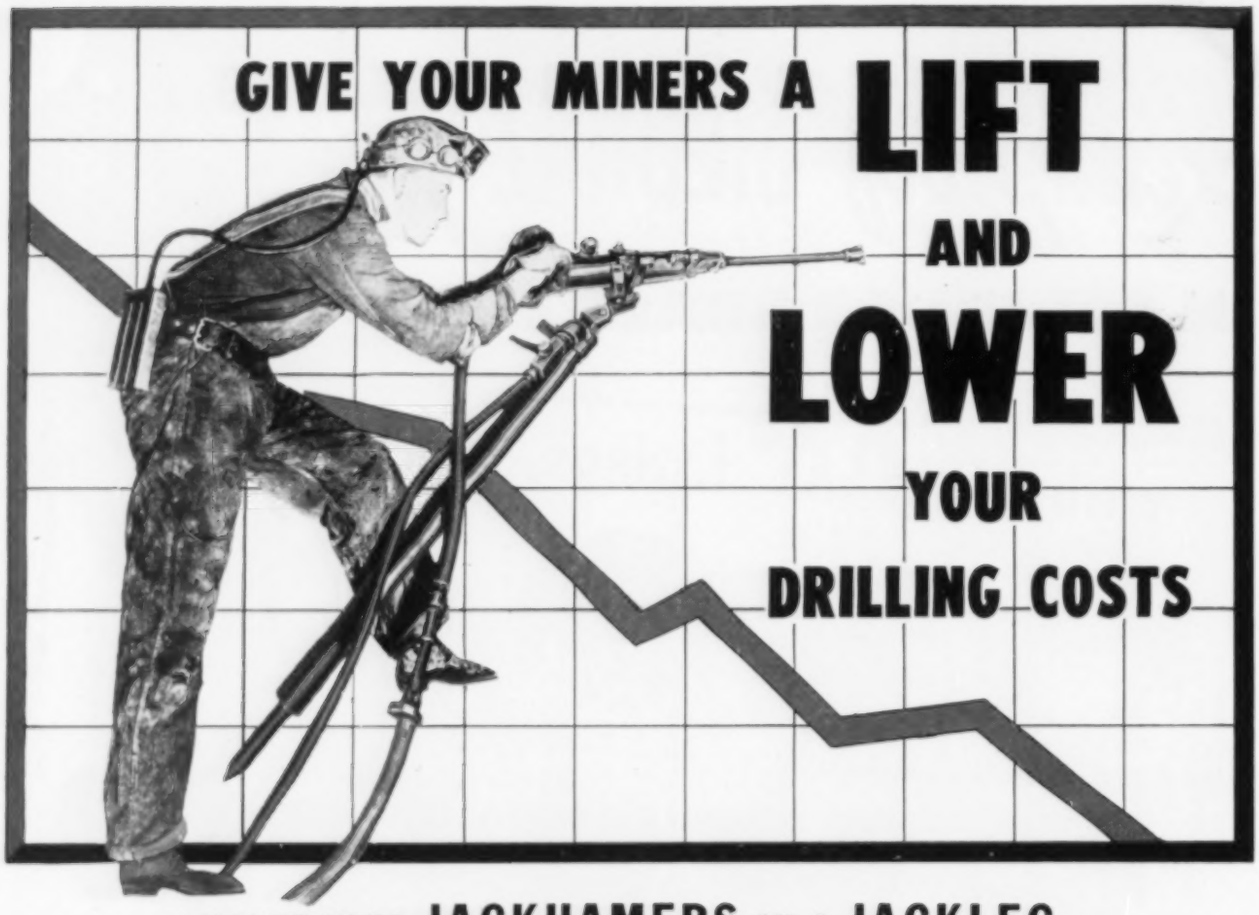

MOUNT YOUR JACKHAMERS ON A JACKLEG

The Jackleg is an air-feed mounting that makes the drilling of horizontal holes with Jackhamers much easier. Miners have told us this, but we ran a test to determine exactly how much physical effort was saved.

The rock where this test was made required *104 pounds* feeding pressure to get maximum drilling speed out of a 55-lb. Jackhamer. The Jackhamer was then mounted on a Jackleg. The operator adjusted the conveniently located Jackleg feed throttle and pulled down on the Jackhamer handle with a force of only *11 pounds*. This means that in attaining maximum drilling results, he saved himself the work of holding up a 55-lb. drill and pushing it into the rock—*an expenditure of 11 pounds of energy as against 104 pounds.*

THERE ARE OTHER ADVANTAGES IN USING JACKLEGS, TOO:

✔ Drilling in all positions is much easier. (*Down holes* can be drilled by quickly removing the Jackhamer from the *Jackleg.*)

✔ Drill upkeep costs are reduced because the machine is properly held to the work. Chuck bushings and fronthead parts give longer service.

✔ Because the Jackleg both supports the drill and feeds it into the rock, heavier Jackhamers with faster drilling speed can be used for horizontal holes. Some mines have increased their footage as much as 50% by putting Jacklegs to work.

✔ Miners are happier with Jacklegs. The work is easier and they drill more footage per shift.

SO GIVE YOUR MINERS A LIFT . . . BUY A JACKLEG TODAY.

THE RETURNS ON YOUR INVESTMENT WILL BE LARGE

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Ingersoll-Rand

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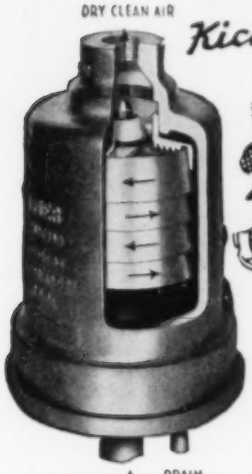
When you install an
ARIDIFIER
you

Kick out compressed air contamination



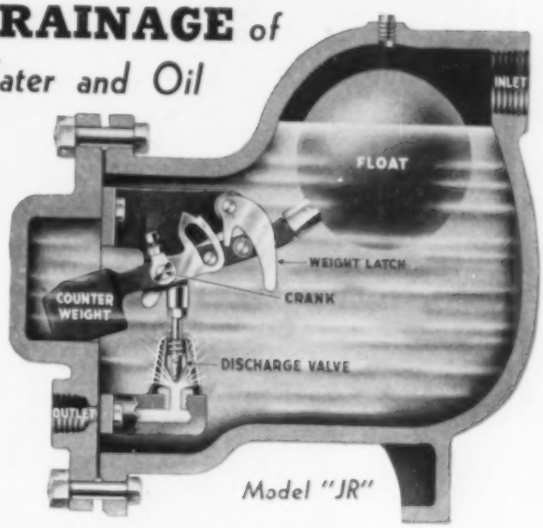
for keeps!

Compressed air contamination is permanently "taken to the cleaners" by Aridifier. Protect air tools and delicate work. Ban breakdowns, rejects. Made in sizes from 3/8" to 10". Write today for bulletin.

LOGAN ENGINEERING CO.
4903 Lawrence Ave., Chicago 30, Ill.

Logan ARIDIFIER
Dries and Cleans Compressed Air

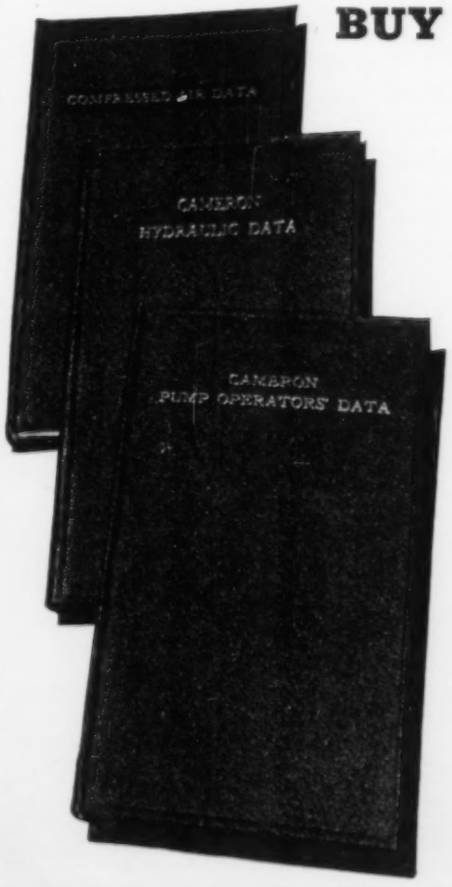
A Compact Compressed-Air Trap
FOR FASTER AND
AUTOMATIC
DRAINAGE of
Water and Oil



Model "JR"

FASTER DRAINAGE! . . . because of its large capacity . . . its weight-operation, giving full positive action . . . its rapid intermittent opening and closing. Welded stainless steel float. Water-sealed discharge valve. Bulletin 341.

W. H. NICHOLSON & CO.
180 OREGON ST., WILKES-BARRE, PA.
Valves ★ Traps ★ Steam Specialties



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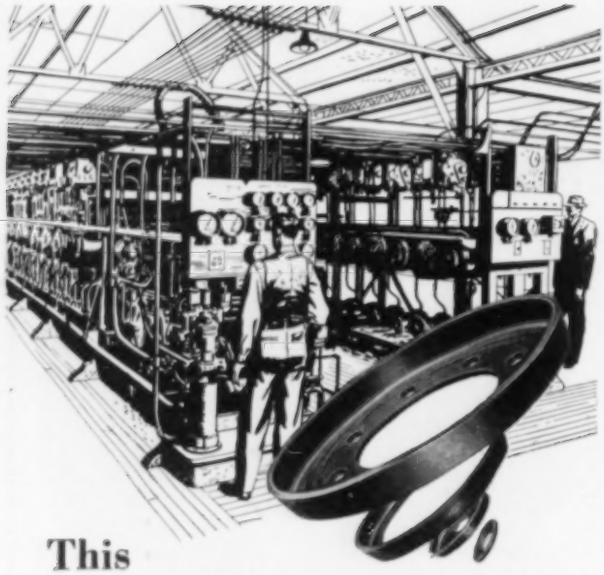

This
"STATIONARY TRAIN"
helped develop
Piston Packing Cups
that serve you better.

PRODUCTS today have to be designed for a *buyers* market . . . and the *extras* in service, in economy, and in freedom from maintenance will decide the sale. If your product utilizes pneumatic or hydraulic cylinders, you can add this margin by installing Wabco Piston Packing Cups.

The material for these cups was developed to meet the need for air brake cylinder packing that would stand desert heat or mountain cold, could get along with lubricants, and that would retain resilience and sealing properties for extended periods. Test equipment like the "stationary train" illustrated helped give the packing its initial check-up, but the most convincing test is provided by the hundreds of thousands of installations that have served dependably for years, on railroads all over the globe.

Wabco Piston Packing Cups are available for original installation in ¾-inch to 30-inch diameters for pneumatic cylinders and $1\frac{3}{16}$-inch to 7-inch sizes for hydraulic cylinders. The exclusive limited compression feature can be furnished in sizes from 1-inch to $7\frac{1}{2}$-inches. Ask for Wabco Packing Bulletin.

Westinghouse Air Brake Co.
Industrial Division - - - Wilmerding, Pa.

FOR AIR COMPRESSORS

class 9213AH3
PRESSURE SWITCH

200 lbs. pressure limit
15 to 40 lbs. differential

• A two-pole device for intermediate-sized motors. Simply-designed, huskily-built mechanism delivers long life and trouble-free operation with a minimum of servicing.

Quickly wired. Range and differential easily adjusted in the field. Offered with or without pressure-release valve for easier motor starting.

Write for Catalog • photos, specifications of Square D pressure switches and related devices. Address Square D Company, 4041 North Richards Street, Milwaukee 12, Wis.

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Make those air tools hum . . . and keep humming. Feed them with clean dry air. • Remove all moisture, oil and scale from your compressed air lines by use of a Murphy aftercooler, separator or trap. Murphy compressed air cleaners and dryers are **guaranteed** to do the job or money refunded. And they **cost less** than tool repairs and idleness incident to the use of wet and dirty air. • Write today giving approximate size of your compressed air system and brief description of condition to be overcome. We'll send literature, prices and our recommendation at no cost and no obligation. Address Department C-14.

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Moisture Elimination Up To 3000 Pounds Per Square Inch

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PARTNERSHIP IN POWER

TANNATE-Rockwood drives help keep your machines running at top production.

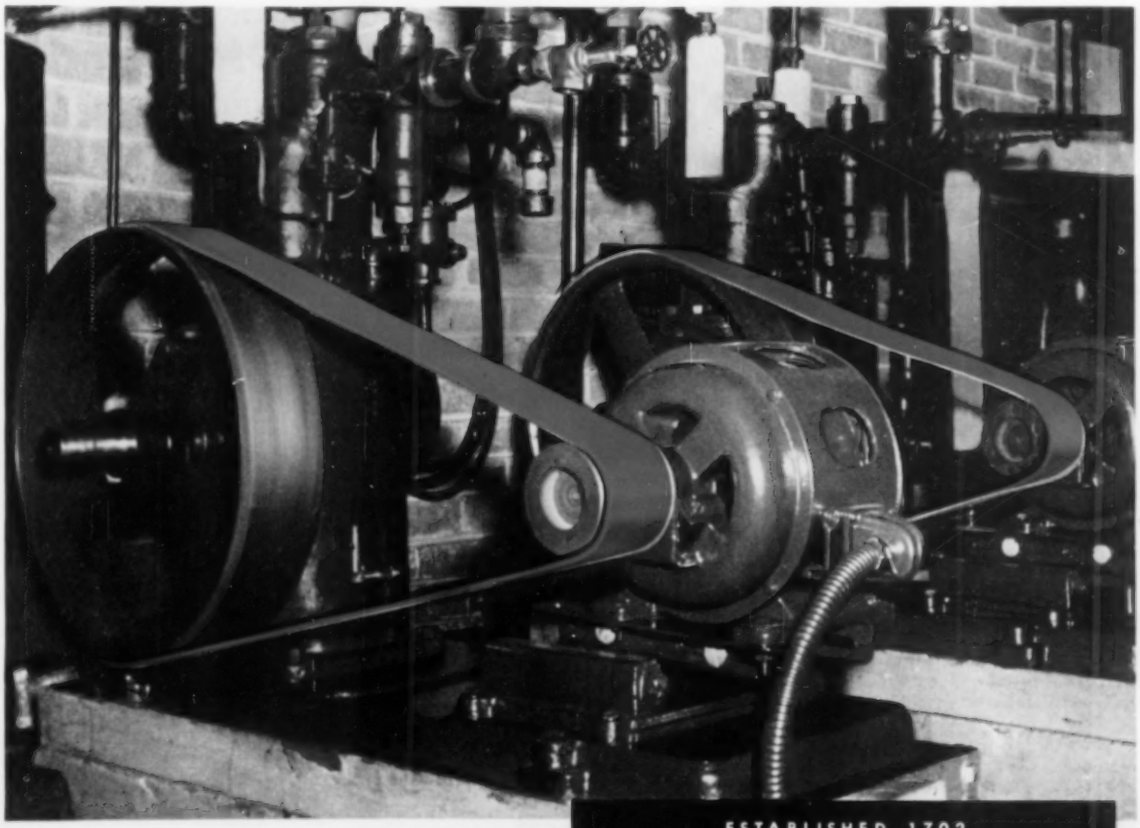
The Rockwood pivoted motor base is designed to maintain correct belt tension regardless of fluctuation in load.

The TANNATE flat leather belt has a high coefficient of friction and great pliability that maintains top speeds even over small pulleys.

TANNATE-Rockwood drives have given notable performance because of their great reliability under severe conditions.

TANNATE-Rockwood drives are easy to install, compact and require little attention. They work well driving vertically, horizontally or at an angle.

May we supply you with more complete information.



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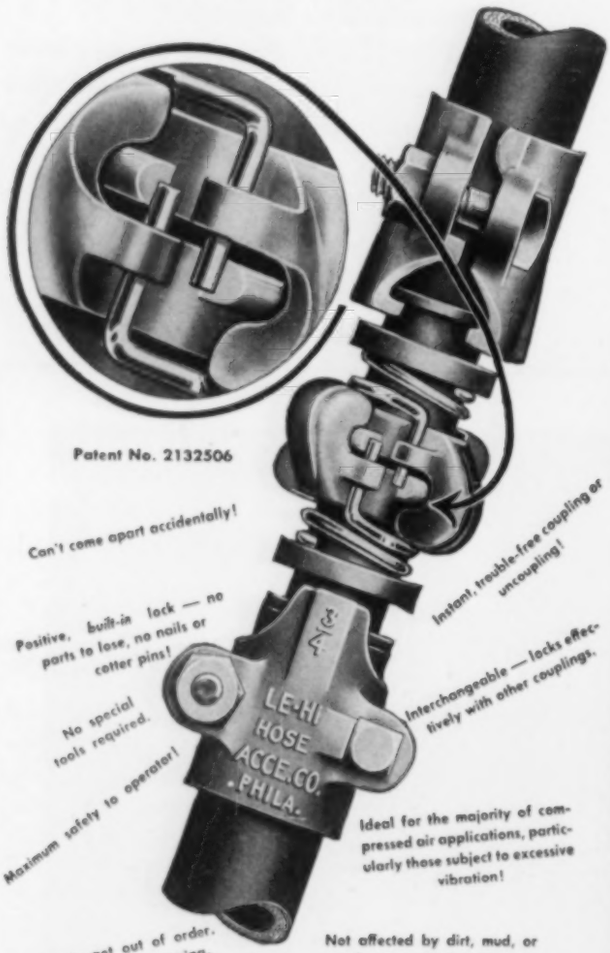
Proved Superior in Compressed Air Service

LE-HI UNIVERSAL HOSE COUPLINGS with *SAFETY-LOCKING*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Can't come apart accidentally!
Positive, built-in lock — no parts to lose, no nails or cotter pins!
No special tools required.
Maximum safety to operator!
Nothing to get out of order. Bronze alloy locking spring.
Instant, trouble-free coupling or uncoupling!
Interchangeable — locks effectively with other couplings.
Ideal for the majority of compressed air applications, particularly those subject to excessive vibration!
Not affected by dirt, mud, or rough usage. Made of tough, corrosion-resistant Bronze.
LE-HI HOSE ACCE. CO. PHILA.

LE-HI Series 150-B Now Available for hose sizes ⅜", ½", ¾" and 1". Hose ends only.

Call your Distributor or write direct — if he hasn't got them yet, we'll see that he gets them pronto!

"LE-HI" MAKES A GOOD CONNECTION

LE-HI HIGH and LOW PRESSURE HOSE COUPLINGS

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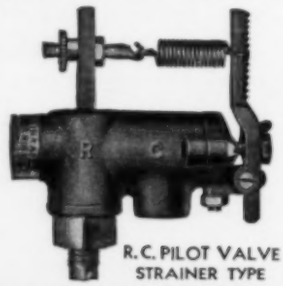
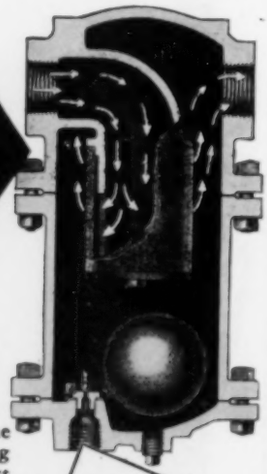
R-C Unloader Pilot Valves (plain or strainer type) are standard on many leading compressors...installed as replacements on thousands of compressors in all parts of the U.S.A. and overseas. The R-C valve—positive in action—cannot chatter...it's always in open or closed position. Adjustment is provided for any unload-to-load range from 3% to 30% of maximum receiver pressure. Install an R-C Unloader Pilot valve—let performance prove its value. Specify air pressure and range of on-and-off operation desired. Write for price and recommendation.



R.C. PILOT VALVE STRAINER TYPE

R. CONRADER CO.
1207 FRENCH STREET - ERIE, PA.
PILOT VALVES for Portable and Stationary Air Compressors provided with Unloaders

NO MOISTURE OR DIRT GETS BY HERE



Johnson Self-Draining Compressed Air Separator.....

Like all Johnson Separators the new Type "SA" Self-Draining Separator combines the two most effective principles of removing moisture and dirt from compressed air:

1. Controlled expansion of air in separator precipitates most of the moisture.

2. A "thousand baffles" of coarse mesh repeatedly changes flow of direction to capture remaining foreign matter.

Self-Draining—a simple but complete trap mechanism built right in, automatically drains separator whenever necessary.

Johnson Separation Devices include Separators for Compressed Air or Steam. After coolers, oil absorbers.

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830 WOOD STREET THREE RIVERS, MICH.

POSITIVE VOLUME CONTROL *with the* "AIR TAMER" BLOW GUN

Positive volume control delivers a breeze or a blast as easy as pointing your finger. Dependable. Air tight. Bronze body. Replaceable brass nozzle tip and valve parts. Steel handle and valve stem. Oil resistant, replaceable valve gasket. Sizes ¼" to ⅜" I. P. T. Write for catalog No. 400. C. A. Norgren Co., 222 Santa Fe Drive, Denver 9, Colorado.

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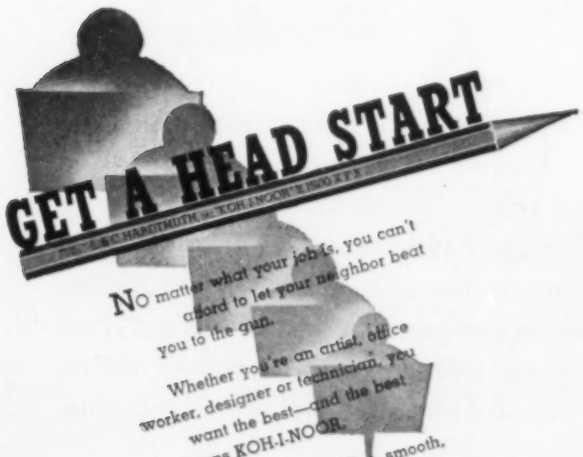

No matter what your job is, you can't afford to let your neighbor beat you to the gun.

Whether you're an artist, office worker, designer or technician, you want the best—and the best means KOH-I-NOOR.

When you work with a fine, smooth, KOH-I-NOOR Drawing Pencil, the advantage is all yours, because you know that KOH-I-NOOR is the Right Pencil for your Job!

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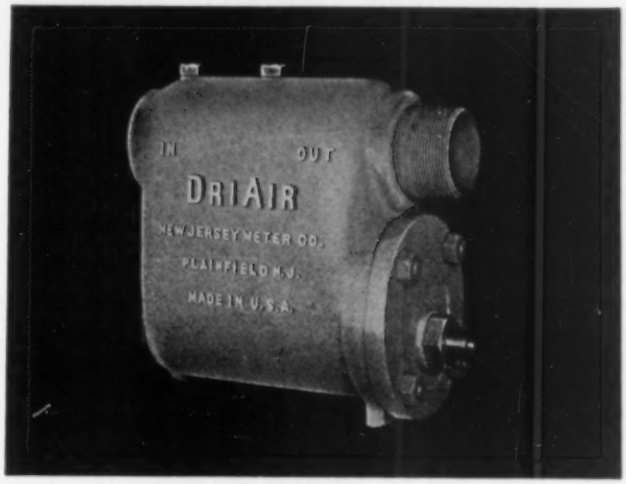
KOH-I-NOOR PENCIL COMPANY, INC., BLOOMSBURY, NEW JERSEY

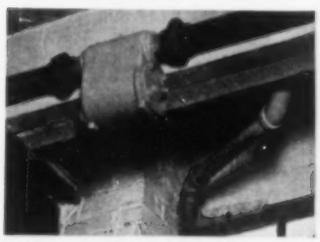
DEPENDABLE PNEUMATIC SERVICE



WHEN EQUIPMENT IS PROTECTED BY

DRIAIR

A COMPLETE SELF-CONTAINED UNIT



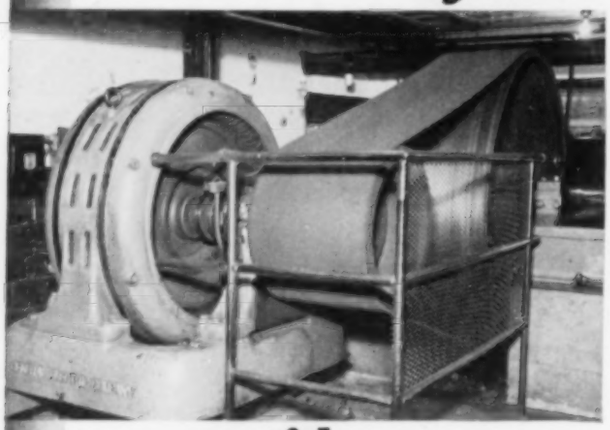
DriAir may be installed by suspending it from the piping, without any other support, or may stand on the floor near equipment being protected.

DRIAIR speeds production by separating and automatically ejecting the condensed water and oil from the air. DriAir collects dirt and rust from the air lines and delivers clean dry air to the tools, thus reducing wear and prolonging their life. All internal parts are made of bronze or copper – resistant to corrosion and practically permanent. Copy of Bulletin DA fully describing the operation of DriAir sent on request.

NEW JERSEY METER COMPANY

PLAINFIELD, NEW JERSEY

Minimize SHUTDOWNS-



with SCHIEREN LEATHER BELTING

ON A PIVOTED MOTOR BASE

Eliminate shutdowns and save precious man-hours! Cut out the time loss in frequent take-ups to compensate for stretch! Here's how: Simply combine SCHIEREN LEATHER BELTING— famous for quality for 76 years—with the constant, automatic, correct tension of a pivoted motor base on short center. SCHIEREN'S unsurpassed leather selection, tannage processes and belting workmanship assure the longest and finest belting performance. And that gives you less wear on bearings, smoother operation, and the utmost from your compressor.

Write for our estimate on your next drive. No obligation whatever.

National Distributors of Rockwood Bases

SCHIEREN QUALITY LEATHER PACKINGS

for every usual and unusual requirement give you lower annual packing cost and higher production efficiency. Send for catalog.

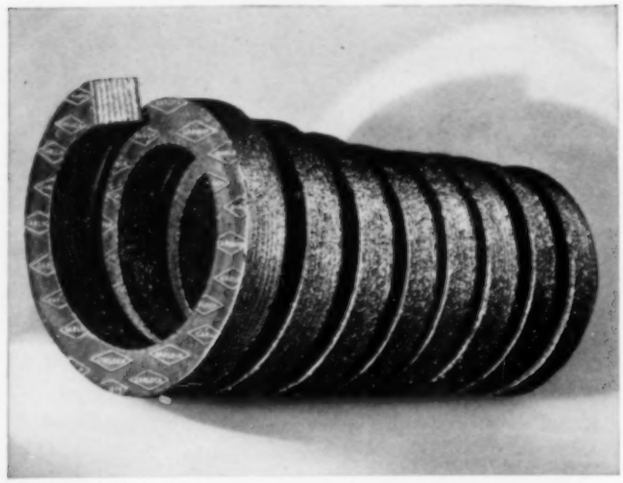
CHAS. A. SCHIEREN CO.

LEATHER BELTINGS • SPECIALTIES

HYDRAULIC PACKINGS

30 FERRY STREET, NEW YORK 7, N. Y.

60 FRONT STREET, WEST, TORONTO, ONTARIO



GARLOCK 777 Spiral for hot and cold water, and low pressure steam. (For ammonia specify GARLOCK 778.) Ring form—GARLOCK 333 for water and steam; GARLOCK 334 for ammonia.

"An Excellent Low Pressure Packing"

THAT'S a typical comment from thousands of engineers who have used GARLOCK 777 for many years. It is the accepted standard rubber and duck packing for hot and cold water, and for low pressure steam. Use GARLOCK 777 on piston and valve rods of engines and on rods and plungers of reciprocating pumps.

THE GARLOCK PACKING COMPANY
PALMYRA, N. Y.

In Canada:
The Garlock Packing Company
of Canada Ltd., Montreal, Que.

GARLOCK 777

Where can the Hercomites and the Gelamites save you money?

In strip mining, metal mining, quarrying, and construction, the Hercomites* and Gelamites* offer greater economy and effectiveness for many blasting jobs. *Investigate!*

HERCULES

EXPLOSIVES DEPARTMENT *HERCULES POWDER COMPANY* INCORPORATED 932 KING ST., WILMINGTON 99, DEL.

*REG. U. S. PAT. OFF. BY HERCULES POWDER CO.

XR-64

A NEW FILTER... A NEW PRINCIPLE

to cut cartridge replacement costs in half

Cuno MICRO-KLEAN filters are available in a wide range of housing designs and replacement cartridges can be supplied in practically any desired length. Loosening a single nut disassembles housing for easy cartridge replacement on model illustrated.

Cuno's MICRO-KLEAN . . . a micronic-type filter made of molded fibre . . . uses Graded Density in Depth to collect more solids before needing replacement.

Here's a micronic filter that eats more dirt without choking.

Experience shows that the Cuno MICRO-KLEAN cartridge maintains efficiency twice as long as other micronic-type cartridges.

That's because the fibre concentration, travelling radially inward from the pressure-side surface to the discharge-side surface, is progressively greater — the spaces between fibres become smaller and more numerous.

MAXIMUM EFFICIENCY— NO CHANNELING

The MICRO-KLEAN filter cartridge is resinous-impregnated molded fibre. Fibres of micronic diameter and graded length are oriented for uniform distribution and formed into a cylindrical cartridge,under conditions permitting a controlled variation of density radially to a pre-determined optimum standard. Thus, as the fluid flows through progressively smaller and more numerous interstices, the foreign particles penetrate to varying depths according to their size. This means that the cartridge can accommodate more solids without affecting flow — and will have a longer efficiency life before needing replacement.

This method of controlling structure gives the same range of density over the entire element. The natural arrangement of the fibre mixture is not disturbed laterally, so the fibres remain criss-crossed in all directions and porosity is uniform concentrically at any depth. This — and the fact that the fibre structure is preserved by resinous impregnation and polymerization — means maximum efficiency for every unit of filter area — and a *sure* protection against channeling.

Cartridges now available will remove all particles larger than 25 microns and the greatest proportion of particles down to 1 micron. (Coarser and finer filtration will be available soon). Use coupon to write for information in more detail.

WHAT MAKES MICRO-KLEAN LAST LONGER?

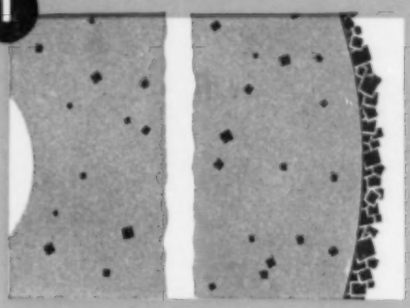
A special method of "felting" and impregnating micronic fibres, developed by Cuno engineers using the resources of a nationally known research foundation, has produced a depth-type micronic cartridge with *exclusive* advantages:

1. Graded Density in Depth, controlled concentrically and radially. Spaces between fibres become progressively smaller and more numerous approaching discharge surface. Smaller particles penetrate to varying depths — no sealing-over of inlet surface.

2. Resinous impregnated — each micronic fibre bonded in position — absolute protection against channeling, rupturing, shrinking or distortion.

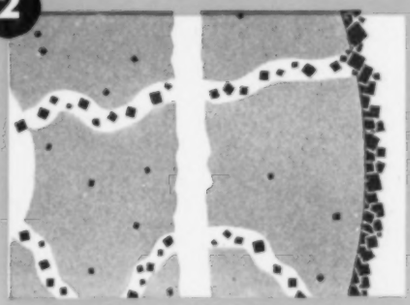
How **MICRO-KLEAN** *Compares with Other Depth-Type Filters*

1



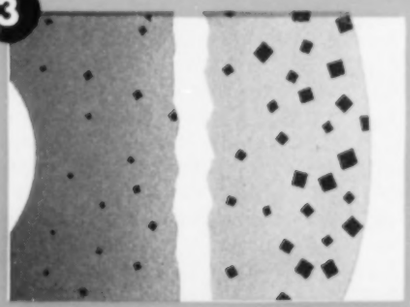
SURFACE LOADING: Minimum openings are same on pressure side and discharge side; therefore, dirt accumulation is largely on pressure side.

2



CHANNELING: Uncontrolled distribution of filter media in the element permits fluid to find channels, passing solids larger than specified.

3



MICRO-KLEAN: Filter medium increases in density in direction of flow, from openings larger than rating to minimum openings on discharge-surface — more solids of all sizes collected within the element before stopping flow. Control of fibre distribution and bonding of fibres in correct position provide permanent channel-free structure.

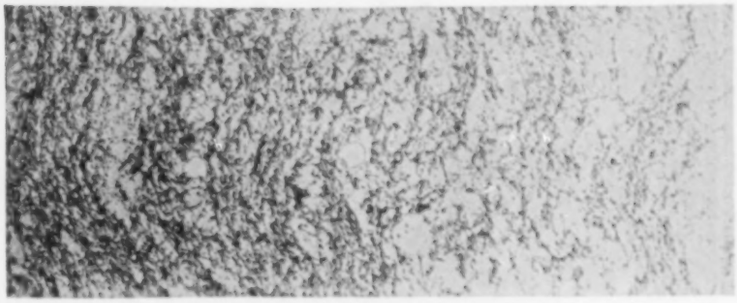
CUNO

Fluid Conditioning

REMOVES MORE SIZES OF SOLIDS

FROM MORE TYPES OF FLUIDS

GRADED DENSITY IN DEPTH



Photomicrograph shows progressively greater fibre density encountered by fluid as it passes from pressure surface (right) through depth of element to discharge surface (left).

MICRO-KLEAN *greatly extends the range of applications for Cuno Fluid-Conditioning*

With MICRO-KLEAN, Cuno — whose filters are used more by Industry than any other brand — offers you the equipment and engineering service to help you handle successfully almost any fluid-cleaning requirement.

Cuno's famous all-metal continuously-cleanable AUTO-KLEAN removes all particles down to .0035″ from practically any fluids other than those containing highly abrasive solids. Cuno's wire-wound self-cleaning FLO-KLEAN is recommended for fluids containing large proportions of highly abrasive solids — mill river water, etc. Cuno's specially-designed COOLANT-KLEAN is for coolants used in precision grinding. Cuno's air filters remove unwanted solids, entrained moisture and oil from compressed air.

And now Cuno's MICRO-KLEAN extends the range of Cuno Fluid Conditioning down to micronic particles!

Cuno maintains a competent staff of engineers in twenty key cities across the country, who will cooperate with you personally and bring to you the active participation of Cuno's factory engineering staff. Sample fluid tests are conducted, either in our laboratory or in the field, upon arrangement.

Meanwhile, have us send you more information on Cuno MICRO-KLEAN. For convenience, use the coupon, listing the types of service in which you are interested.

MICRO-KLEAN HOUSING DESIGNS

Complete range from ⅜″ to 4″ inlet and outlet connections, handling up to 300 gpm. Other sizes available soon.

MICRO-KLEAN CARTRIDGE SIZES

1″ I. D. and 2¾″ O. D. standard at present. Standard lengths: 4″, 8″, 10″. Special lengths available for built-in installations or for housings already in service.

CUNO ENGINEERING CORPORATION
1717 South Vine Street, Meriden, Conn.

Please send me information on Micro-Klean Filter relative to the services checked.

- ☐ Lubricating Oil
- ☐ Hydraulic Oil
- ☐ Fuel Oil, Diesel
- ☐ Water and Water Solutions
- ☐ Compressed Air
- ☐ Acids
- ☐ Fuel Oil, burner (Domestic and industrial)

Send information on MICRO-KLEAN to handle the following: (Write any other fluid-cleaning problem here.)

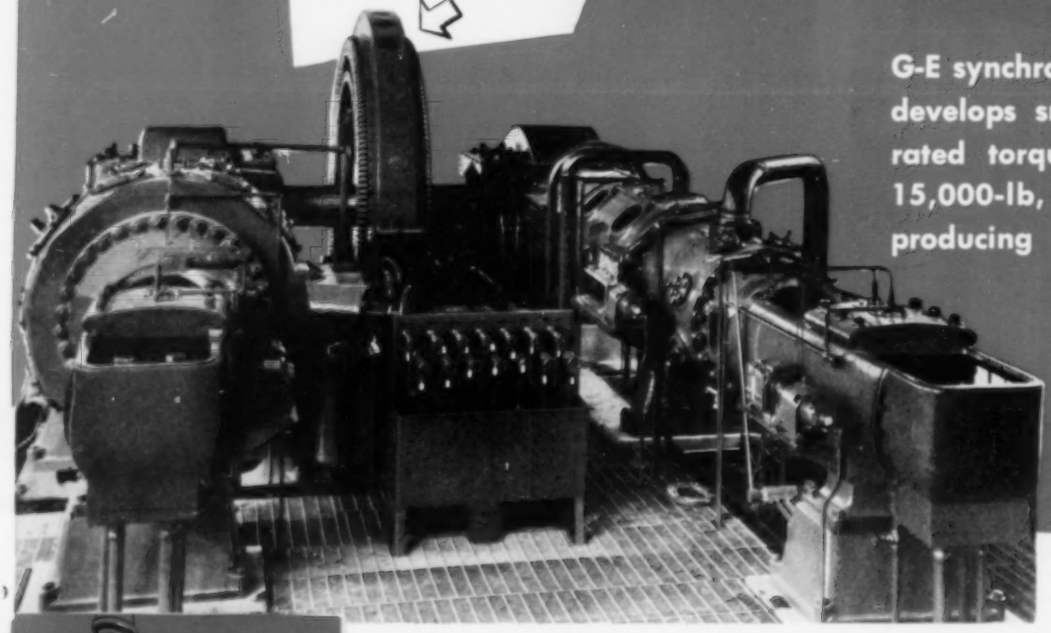
.....

NAME .....

COMPANY .....

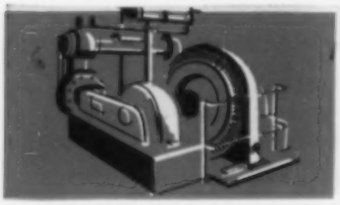
ADDRESS .....

"Push" PUTS THE PUSH INTO WORLD'S BIGGEST HIGH-PRESSURE COMPRESSOR

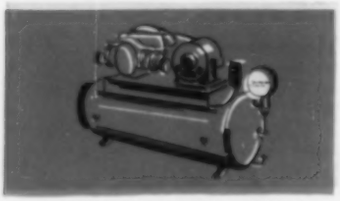


G-E synchronous motor develops smooth, full-rated torque to drive 15,000-lb, ammonia-producing compressor.

G-E Close-Coupled, High-Speed Synchronous Motors



G-E Direct Connected Low-Speed Synchronous Motors



G-E Belt-Connected Tri-Clad Motors

In one of the synthetic ammonia plants of Hercules Powder Company, you will find the biggest, high-pressure compressors ever made. Every minute, the unit takes a boxcarful of nitrogen and hydrogen in and passes it through seven stages of compression. The gas is discharged at 15,000 lbs per sq in.—greater than the pressure of ocean water at its deepest level.

As with any continuous chemical process, this compressor is called on to give long, trouble-free service. Frequent outages for repairs would create heavy material and labor losses. Thus, only a drive motor with unusual strength and stamina could be used. A G-E synchronous motor met these stiff requirements for two very good reasons.

First, the motor was correctly engineered to dovetail with the specific characteristics of the compressor. By providing the proper amount of flywheel effect, any pulsations in the reciprocating compressor which might affect the motor and the power supply line are smoothed out.

Second, G-E synchronous motors are highly efficient. They make possible additional worthwhile power savings through power factor improvement. Direct-connected to the driven machines, they save valuable plant space in addition to eliminating expense and maintenance of mechanical transmission.

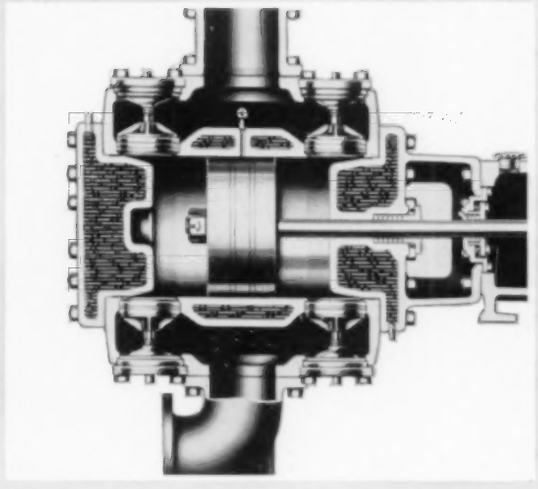
For over 50 years, G.E. has been supplying synchronous motor drives for compressors rated from 15 lbs to 15,000 lbs. Important to the compressor user is the close co-operation that exists between compressor manufacturers and G.E., resulting in complete co-ordination, engineering-wise, between compressor and drive. One sure way to assure yourself of smooth performance and operating continuity from your next compressor is to specify a G-E synchronous motor drive. *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

GENERAL ELECTRIC

662-23C-182

Synchronous Motors

COMPRESSOR CYLINDERS
DESERVE AN OIL WITH QUALITIES



like these:

1. **Low gum-and carbon-forming tendencies to prevent valve sticking.**
2. **Low-temperature fluidity to avoid "dry starting."**
3. **Low volatility to reduce carry-over to air line.**
4. **Rust-preventive properties to protect cylinder walls and rings.**

SHELL COMPRESSA OILS
provide all these qualities

GUM FORMING and excessive carbon are usually evidence that an oil oxidizes easily. Shell Compressa Oils are particularly free of these tendencies because of special care in selecting crudes and the use of solvent extraction refining which removes all readily oxidized compounds. Not only is a minimum of carbon formed, but that minimum is soft and fluffy . . . valves stay clean and free.

Fluidity at low temperature is necessary to protect cylinder parts both in starting and before operating temperatures are reached . . . only a well-balanced blend such as Shell Compressa Oil gives cylinder walls protection under all conditions.

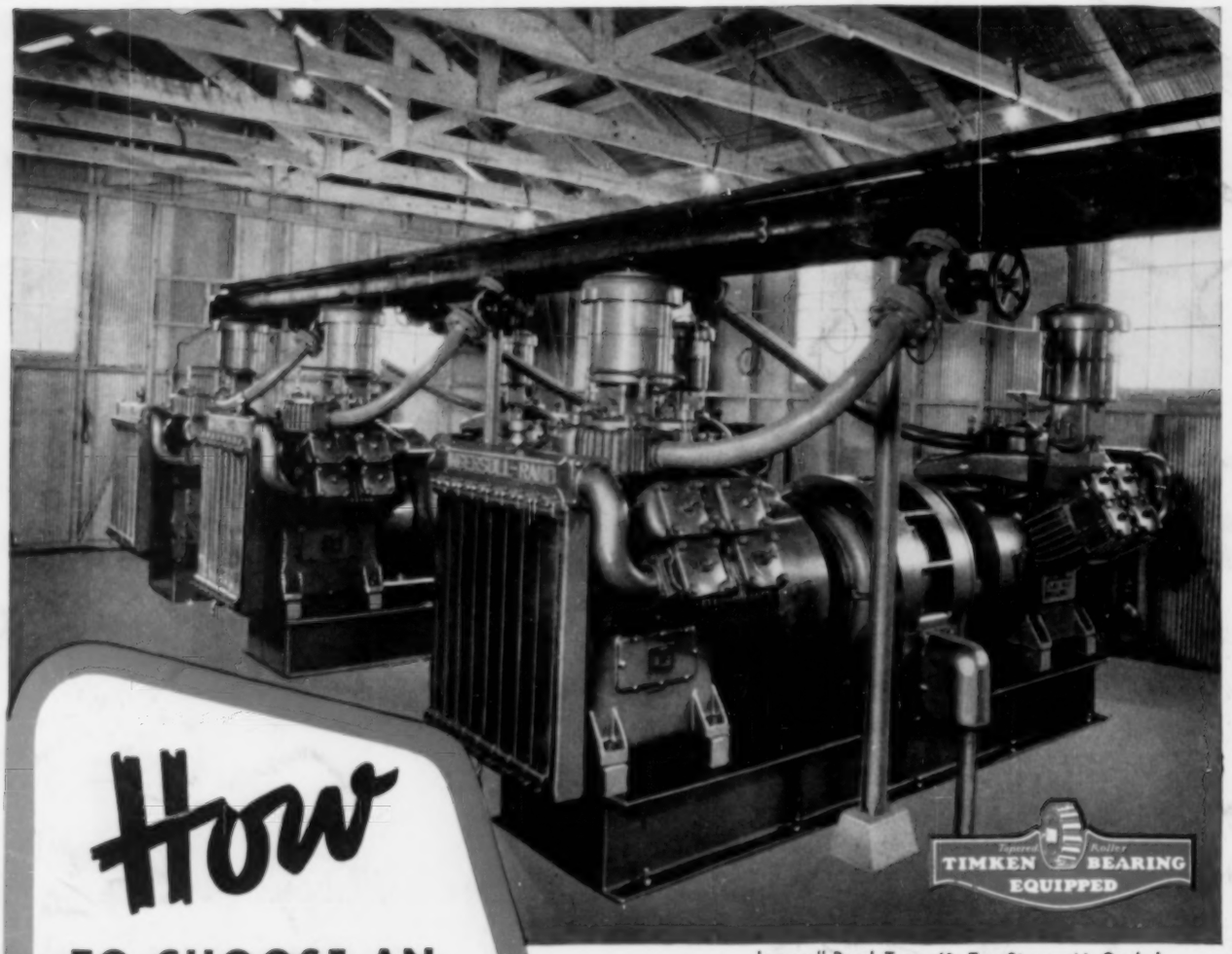
Volatility has a lot to do with cylinder oil consumption. Both in the choice of crudes and in refining, those components affording low volatility are selected for Shell Compressa Oils. Result: safe lubrication with minimum feed.

Moisture conditions favorable to rusting exist in compressor cylinders, especially during shutdown. The rust-preventive properties of Shell Compressa Oils give extra protection to cylinder walls and ring edges at all times.

The Shell Lubrication Engineer will gladly give you specific advice on the lubrication of any type of Compressor. For informative literature about compressed air equipment lubrication, write to Shell Oil Company, Incorporated, 50 West 50th St., New York 20, N. Y.; or 100 Bush St., San Francisco 6, California.

SHELL COMPRESSA OILS

SHELL



Ingersoll-Rand Type 40, Two-Stage, Air-Cooled Compressors operating near Blue Mountain Tunnel, Pennsylvania Turnpike.

How TO CHOOSE AN *Anti-Frictionized* COMPRESSOR

When selecting an air compressor equipped with anti-friction bearings, make sure of getting anti-friction performance in full; insist on Timken Tapered Roller Bearings.

The application of Timken Bearings on compressor crank shafts accomplishes much more than the elimination of friction. It makes full provision for carrying radial, thrust and combined loads; it holds the crank shaft assembly in correct and constant alignment; and thus extends its beneficial effects far beyond the possibilities of other kinds of bearings.

Don't specify "anti-friction bearing equipped"; say "Timken Bearing Equipped" and remove all doubt. Furthermore, look for the trade-mark "TIMKEN" on every bearing that goes in your equipment. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS